INTEGRATED OCCUPATIONAL PROGRAM

Program of Studies/Curriculum Guide

SCIENCE 16

INTERIM – 1990

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ADDENDUM

Addendum to Integrated Occupational Program Program of Studies/Curriculum Guides 16-Level Courses

COMMUNITY PARTNERSHIPS

School administrators and teachers are advised that the **APPLICATION FOR APPROVAL OF WORK SITES/STATIONS** (Parts A and B) must be completed for each work site/station at which an Integrated Occupational Program (I.O.P.) student is placed.

In addition, each student involved in any off-campus I.O.P. learning activity must be registered by the school/school jurisdiction as being placed in an approved work site/station.

Specific procedures and legislation about work experience (community partnerships) is provided in the following documents:

> *Alberta Education Program Policy Manual*
> (Available upon written request from Central Support Services,
> 11160 Jasper Avenue, Edmonton, Alberta, T5K 0L2.)
>
> *Work Experience Program: Teacher Resource Manual Junior and Senior High School,*
> Alberta Education, 1990
> (Available from the Learning Resources Distributing Centre,
> 12360-142 Street, Edmonton, Alberta, T5L 4X9.)

Science 16

Program of Studies/Curriculum Guide

Grade 10

INTERIM – 1990

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NOTE

CURRICULAR DOCUMENT FORMAT

To provide educators with a comprehensive overview of the Integrated Occupational Program, all I.O.P. curricular documents have adopted the format of combining the Program of Studies and Curriculum Guide into one document. The shaded statements or segments within this document indicate the prescriptive contents of the program of studies. All other advice and direction provided are suggested only.

The terminology and format used in this document reflects policy in effect when I.O.P. curriculum development began in 1987.

METRICATION POLICY

It is the policy of Alberta Education that "SI units become the principal system of measurement in the curriculum of the schools in the province". In preparing students for transition to the workplace where imperial/U.S. measurements may still be in use, both SI metric and other units of measurement are addressed in the practical arts/occupational component of the Integrated Occupational Program.

The comparison/teaching of metric units with other units of measurement should be restricted to those that are relevant to student needs as reflected by common usage in course-related workplaces.

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ASSOCIATE DIRECTOR: A. A. (Scotty) Day

INTEGRATED OCCUPATIONAL PROGRAM MANAGER: Michael Alpern

PROGRAM MANAGER, SCIENCE: Gary Bertrand

INTEGRATED OCCUPATIONAL PROGRAM TEAM:

Jeanne Cooper
Lorraine Crawford
Marilyn Dyck
Linda Elliott
Jan Marvin
Kathy McCabe
Paul McNair

INTEGRATED OCCUPATIONAL PROGRAM REVIEW COMMITTEE:

Stuart Adams	– County of Strathcona No. 20
Pat Boon-Anderson	– Lac La Biche School Division No. 51
Christopher Harrison	– Alberta Vocational Centre, Edmonton
Ed Holt	– Conference of Alberta School Superintendents
Alex McCaughan	– Alberta Education
Wayne Nixon	– Alberta Career Development and Employment
William Smolak	– Alberta Teachers' Association
Doug Tarney	– Wetaskiwin School District No. 264

EDITING: Elizabeth McCardle

COPY EDITING: Kim Blevins

DESKTOP PUBLISHING: Lin Gray
Cheryl Stoochnoff
Esther Yong

ILLUSTRATOR: Kelvin Ogden

SECRETARIAL: Rita Flint
Jacquie Reinprecht
Marcie Whitecotton-Carroll

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RATIONALE

The Integrated Occupational Program (I.O.P.), developed as an outcome of the *Secondary Education in Alberta* (June 1985) policy statement, is a program for students who have experienced difficulty in learning. The program consists of both core and complementary courses designed to develop concepts, skills and attitudes necessary for everyday living.

The Integrated Occupational Science Program provides a two-course sequence in science known as Science 16-26. Science 16 allows students to meet the credit requirements of the Certificate of Achievement. Science 26 allows students to develop further their knowledge and skills in science, and facilitates transfer to the General High School Diploma Program.

The Science 16-26 program provides for the development of essential concepts, skills and attitudes in science that will enable students to function successfully in the home, classroom, workplace and community. The program is activity-based, and provides opportunities for students to relate essential concepts, skills and attitudes to their own world of experience and needs. This approach will foster an appreciation of science for its usefulness and relevance, and will motivate students to participate in the learning process.

As science and technology affect our lives in so many ways, it is necessary for students to appreciate and understand the dynamic relationships that exist among science, technology and society. Students must understand how science is used in technology, and how technology affects the quality of our life and the health of our planet. Students must recognize the value of technology as well as the problems that result from its uncontrolled use. Societal issues involving science and technology have been integrated throughout this science program. Community partnerships provide opportunities for students to become involved in the community by way of meaningful activity linked to the science program.

Students are often unaware of strategies they may generate and employ to become more efficient in their cognitive functioning. Evidence supports, however, that students with learning difficulties can perform strategically if taught to do so. The strategies and skills for scientific inquiry, problem solving and decision making that are developed and applied throughout the Science 16-26 program will provide students with a systematic and logical approach for dealing with a variety of phenomena encountered in their environment. As students learn to understand and control the outcome of tasks demanded of them, confidence in taking risks and accepting challenges will further their ability to solve problems and make responsible decisions in everyday life.

PHILOSOPHY

The Integrated Occupational Science Program focuses first and foremost on the needs of the learner. As attitude and self-esteem have powerful influences over learning, the program must foster within each student a positive self-concept and a positive attitude toward learning. The concepts, skills and strategies delivered by the program must:

- provide meaningful and relevant experiences
- be appropriate to student ability
- provide for student success
- enable students to understand their personal environment better.

Students vary in the way they receive, process, recall, apply and communicate information. Each student has a preferred way to approach learning tasks. Instructional planning and delivery must include careful assessment of each student's developmental characteristics, knowledge, skills and preferred way of learning. Adjustments to instructional delivery may often be necessary to ensure that individual student needs are being met.

An integrated approach suggests the linking together of various scientific skills and strategies into meaningful investigations and activities. Many opportunities are provided for instruction through "thematic study", through the integration of skills "across the curriculum", and through application of skills to "real life" situations. This approach adds a motivational dimension to the program, and provides students with direct assistance in transferring specific skills to more generalized situations. Relevancy to daily living and future employment is emphasized throughout the program.

Although students are at various stages of cognitive development, most students will continue to use concrete operational thinking. Students will depend upon personal experience and personalized content in order to link new ideas with prior knowledge. As the process of analysis must be based on tangible experience, learning activities should begin at the concrete level. High emphasis should be placed on experiential learning involving first-hand investigation. An experiential approach will enable students to relate what they are learning to past experience. While concepts and skills cannot be developed in the absence of supporting facts, the knowledge component of science should not be over-emphasized. Strategies that will assist the learner in progressing from the concrete level of thinking to more abstract thought processes have been provided throughout this *Program of Studies/Curriculum Guide* and in the corresponding *Teacher Resource Manual.*

It is intended that the content and process of the Science 16-26 program provide a student-centred, personal and practical approach to science. A program with these emphases will ensure students' success in developing concepts, skills and attitudes that are requisite to responsible participation in the home, classroom, workplace and community.

GOALS OF THE SCIENCE 16 PROGRAM

The Integrated Occupational Science Program is designed to assist students in developing and maintaining:

- positive and realistic self-images
- constructive relationships with others
- positive attitudes toward science and lifelong learning.

Within the Science 16 Program, students will be expected to:

- develop essential concepts, skills and attitudes of science that are required for responsible participation in the home, the school, the workplace and the community

- apply scientific concepts and skills to daily life and occupational situations that are experienced both inside and outside the science classroom

- develop critical and creative thinking skills, and apply these skills to a variety of practical situations through processes of scientific inquiry, problem solving and decision making

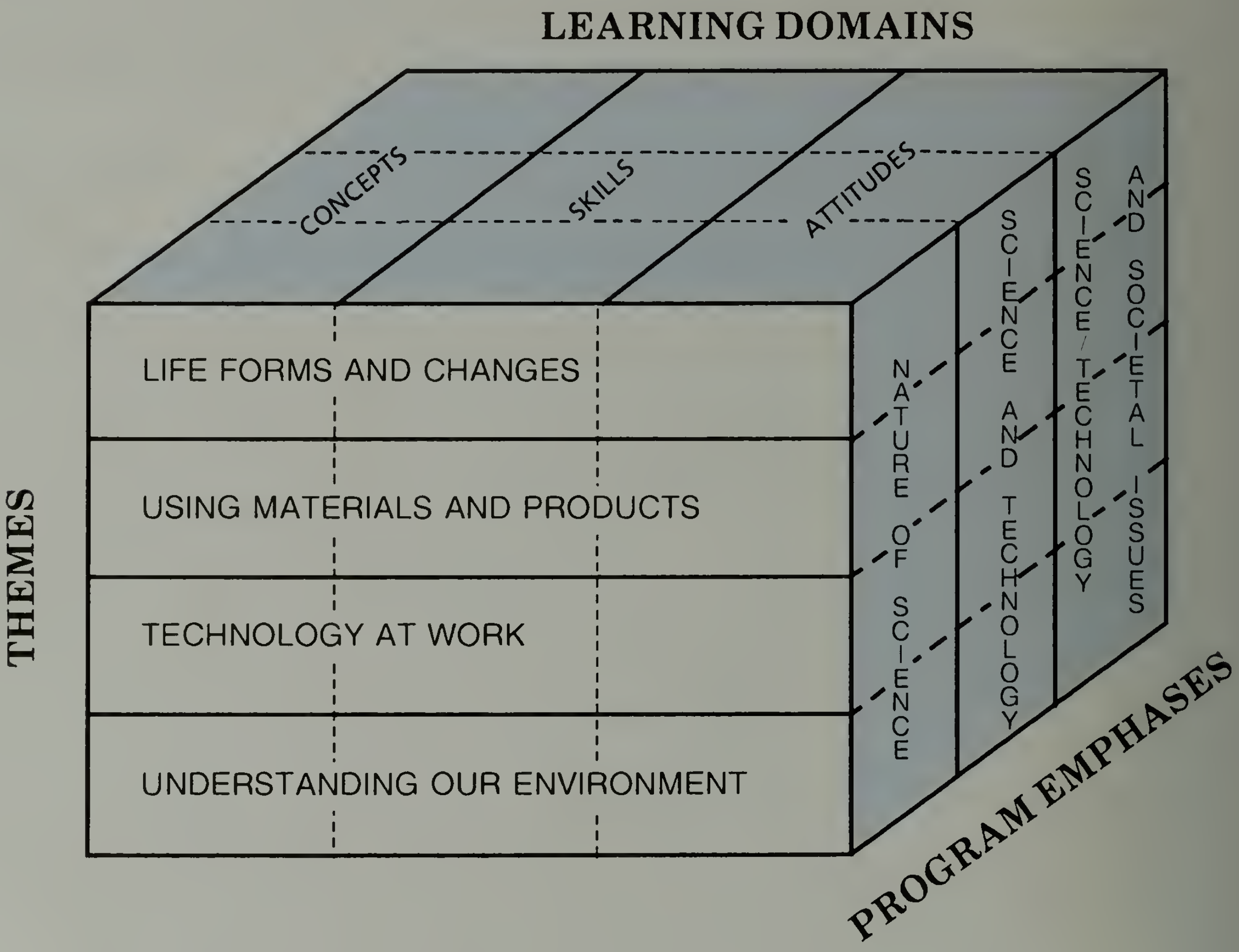
- develop appropriate knowledge, skills and attitudes in the responsible use of science and technology

- develop communication skills that are used when gathering, interpreting and applying scientific knowledge.

MODEL FOR THE SCIENCE 16 PROGRAM

The model for the Science 16 Program illustrates an integration of program components, thus emphasizing a "holistic" approach to instruction and learning. Three components that provide a basis for program planning are represented on the cube.

- Learning Domains
- Program Emphases
- Themes



The themes have been deliberately placed on the "face" of the cube to highlight their importance in planning for relevant and meaningful learning experiences.

LEARNING DOMAINS

The learning domains provide a structure for the science program by identifying the concepts, skills and attitudes that students will be expected to develop. The **concepts** component includes major ideas and understandings in science that enable students to interpret objects and events in their natural environment. The **skills** component includes a range of thinking skills appropriate to conducting investigations in science, and useful in a variety of practical situations. The science program fosters the development of student **attitudes** that are associated with the successful study and practice of science, as well as appropriate feelings, opinions, beliefs and appreciations about various aspects of the scientific enterprise.

Although students are expected to develop the concepts, skills and attitudes identified for Science 16, they are not meant to be addressed separately or sequentially. Rather, they should be addressed within the overall context of themes that provide students with the practical experiences and processing strategies that foster responsible participation in everyday life. Caution should be exercised to avoid over-emphasis on memorization and recall of isolated facts that are of little practical use in daily life.

General learning objectives that correspond to the three learning domains are provided below. **Specific learning objectives** that support the development of concepts, skills and attitudes within thematic contexts are provided throughout the "Program of Studies/Presentation of Content" section of this document (see "Concepts", "Skills" and "Attitudes").

CONCEPTS

Most students will continue to use concrete operational thinking, depending upon personal and tangible experiences in order to link ideas. Therefore, concept development should begin with an operational understanding of ideas fundamental to science, and encourage students to extend their thinking to more abstract levels that are commensurate with their cognitive abilities.

Students will be expected to demonstrate an operational understanding of ideas fundamental to science, including:

- matter has structure and composition, and there is an interaction among its components
- matter and energy are conserved in reaction and living systems
- living organisms are interdependent with one another and with their environment
- life forms exhibit uniquity, diversity, and a changing nature
- biological, chemical and physical systems are in a state of dynamic equilibrium.

SKILLS

Students need to possess a range of thinking skills in order to investigate natural phenomena, solve practical problems and resolve science related issues. Some skills involve the use of formal operations (i.e., hypothetical thinking), and must be developed through carefully planned learning experiences that focus on their use. The process of mediation (e.g., asking appropriate questions, modelling and "talking through" complete thought processes) will assist students to develop and consciously use thinking skills that are appropriate to the situations they encounter. Learner ability will determine the degree to which skills are applied at an independent level throughout investigations undertaken in the science program.

The list of skills provided below serves to guide the design of learning experiences and the construction of assessment schemes. These skills are not intended to be developed separately or sequentially, but rather concurrently with concept and attitude components.

Students will be expected to demonstrate an ability to:

- distinguish between relevant and irrelevant information
  e.g.,
  - define problems/identify issues
  - set goals by establishing purpose and direction
  - formulate questions to guide research/inquiry
  - identify variables

- gather information or data
  e.g.,
  - use an experimental design or research plan
  - make qualitative and quantitative observations
  - effectively use apparatus and equipment

- arrange or structure information so it can be readily understood or presented
  e.g.,
  - classify
  - order and identify patterns/trends
  - draw charts/graphs/diagrams
  - express data in the form of a mathematical relationship

- analyze data or information
  e.g.,
  - identify main ideas/attributes/components
  - identify patterns and relationships
  - identify errors
  - detect bias

- make connections among new ideas and prior knowledge, and generate information beyond that which is given
  e.g.,
  - explain and elaborate
  - predict and hypothesize
  - infer and generalize from the data or information
  - design experiments or devise a plan for research
  - identify further problems, questions and issues to be investigated

- integrate new information with prior knowledge
  e.g., – summarize and communicate findings
  – develop consensus within a group
  – make a decision or develop a conclusion/solution

- assess the logic and quality of ideas/information
  e.g., – consider consequences
  – establish criteria to judge data
  – assess a design or approach taken to inquiry, problem solving or decision making
  – assess the achievement of goals set.

ATTITUDES

Critical to the development of concepts and skills in science is the attitude with which students approach an investigation. Students are often uneasy and hesitant to involve themselves in situations where procedures are not easily determined and outcomes are not evident. The science program must nurture the development of appropriate attitudes through an atmosphere that provides encouragement, flexibility and acceptance.

Students will be encouraged to develop attitudes associated with the successful study and practice of science.

e.g., – curiosity
– respect for evidence
– inclination to tolerate uncertainty
– open-mindedness
– critical-mindedness
– perseverance
– creativity and inventiveness
– appreciation for group work
– confidence in personal ability
– respect for accuracy and precision
– concern for safety.

Additionally, students will be encouraged to develop the feelings, opinions, beliefs and appreciations that individuals have formed as a result of interacting with various aspects of the scientific enterprise.

e.g., – a positive attitude toward mathematical and scientific process skills
– an appreciation for the utility of computational competence and problem-solving skills
– an appreciation that, in solving problems scientifically, new technologies develop
– an appreciation of the roles that science and technology play in serving human needs
– an appreciation of the need for problem solving and informed decision making at both personal and societal levels
– an appreciation of the contributions science and mathematics have made to our cultural heritage and civilization
– an appreciation of the contributions and limitations of scientific and technological knowledge to societal decision making
– an appreciation that ethical dilemmas may arise from the application of scientific research and/or technological developments
– a sensitivity to the living and non-living environment
– an appreciation of the roles of science and mathematics in explaining the complexity of the natural world.

PROGRAM EMPHASES

The program emphases take into account both the **content** and **intent** of science education, and foster the development of concepts and skills that enable students to interpret and process information in their environment relative to the demands of everyday life. Each program emphasis provides a message about why students are to study particular sets of concepts/skills. A **Nature of Science** emphasis focuses attention on science as a disciplined way to develop explanations for natural phenomena. A **Science and Technology** emphasis directs attention to the relationship between science and technology, and how science and technology are used in solving practical problems. A **Science/Technology and Societal Issues** emphasis focuses attention on how science and technology influence and are influenced by societal issues, and how society deals with issues that have a scientific or technological component.

General learning objectives that correspond to each of these program emphases are provided below. **Specific learning objectives** that support the development of related concepts and skills within thematic contexts are provided throughout the "Program of Studies/Presentation of Content" section of this document. As themes vary in the degree to which they lend themselves to each of the three program emphases, a primary emphasis has been suggested for each theme.

THE NATURE OF SCIENCE

A focus on the nature of science and the inquiry process will enable students to understand the way in which scientific knowledge is gathered, as well as use this knowledge in conducting investigations of their own.

Students will be expected to demonstrate an understanding that:

- science is a disciplined way to develop explanations for the events and objects of the natural world
- science is comprised not only of an accumulated body of knowledge, but also of the processes by which that knowledge is developed
- empirical evidence plays an important role in the development of scientific knowledge
- physical laws and theories attempt to explain the universe
- scientific knowledge is not fixed, but, rather, is based on theory that may change as additional evidence accumulates
- scientific explanations are developed through interpretations and conceptual inventions that are theoretical in nature.

Themes with an emphasis on the nature of science will provide opportunities for students to investigate objects and events in the natural world that are relevant to personal experience and need. Particular attention will be placed on developing strategies for gathering information through observation and experiment. A framework that can help students to understand the processes used in conducting scientific inquiry is provided in the "Methodology" section of this document (see "A Framework for Conducting Investigations in Science").

SCIENCE AND TECHNOLOGY

A focus on science and technology will enable students to understand the interaction between science and technology, and how science and technology contribute to the solution of practical problems in everyday life.

Students will be expected to demonstrate an understanding that:

- technology facilitates the solving of practical problems
- technological development includes both products and processes
- the functioning of products and processes may be explained using scientific knowledge
- science can be used to advance technology, and technology can be used to advance science
- existing and emerging technologies have application in many everyday and work-related situations
- scientific knowledge and technology have limitations.

Themes with an emphasis on science and technology will provide opportunities for students to solve practical problems of a technological nature through the application of scientific concepts and principles. Particular attention should be given to problems that incorporate hands-on activities in their solution. Although there are many ways to approach a problem, the framework for conducting investigations provided in the "Methodology" section may assist students to organize their problem-solving efforts.

SCIENCE/TECHNOLOGY AND SOCIETAL ISSUES

A focus on science/technology and societal issues will enable students to understand interactions that occur among science, technology and society, and how science and technology influence and are influenced by societal issues.

Students will be expected to demonstrate an understanding that:

- science and technology have impact on our lifestyle, occupational choice, environment and welfare
- technological products and processes develop in response to societal needs and wants
- economic, political and ethical perspectives often interact with science and technology and exert significant influence on each
- often the products of science and technology are accepted and used by society before the full extent of benefits/problems resulting from their use can be fully known
- scientific, technological and societal aspects of an issue help to inform the societal decision-making process
- compromises are often needed in order to arrive at workable solutions involving science and technology in society.

Themes with an emphasis on science/technology and societal issues will provide opportunities for students to investigate the impact of science and technology on their personal lives and in their local community. Particular attention should be placed on developing a process for resolving societal issues that have a scientific or technological component. The framework for conducting investigations provided in the "Methodology" section outlines a general action plan that can help to guide students through the decision-making process.

THEMES

Themes provide the setting in which concepts, skills and attitudes are linked together in meaningful activities. Thematic activities will focus attention on a particular topic or concern, and provide students with practical experiences that contribute to responsible participation at home, at school, in the workplace, and in the community.

The thematic approach provides for the natural integration of concepts and skills, and assists the student to solve problems and make informed decisions that relate to real issues affecting their lives. A well-constructed theme allows for activities in all levels of thinking (e.g., recall, application, analysis, synthesis and evaluation). Other advantages of thematic planning and organization include:

- provision for cumulative development of background knowledge and skill, enabling students to relate and transfer learning from one day to the next
- flexibility in responding to student interests and needs. Teachers can address local interests and needs within each theme, as well as individual differences in cognitive development and ability. Learning will be facilitated when students see activities as worthwhile and meaningful
- opportunity for concrete and experiential learning in relevant and meaningful settings
- opportunity to use a wide variety of activities, media and resources
- opportunity to develop strategies and skills in problem solving and decision making through investigations that reflect real issues and problems present in the local community.

Relevant themes that provide for the integration of concepts, skills and attitudes are described throughout the "Program of Studies/Presentation of Content" section of this document and the *Teacher Resource Manual*. At the local level, teachers may wish to develop additional themes that expand upon and reinforce learning objectives.

The chart below provides the titles of themes developed for Science 16, and illustrates their relationship to themes developed for Science 26. A primary emphasis is suggested for each theme inside the brackets.

	SCIENCE 16	SCIENCE 26
Theme A **LIFE FORMS AND CHANGES**	SYSTEMS OF THE HUMAN BODY **(NS)**	PERSONAL HEALTH AND LIFESTYLE **(STS)**
Theme B **USING MATERIALS AND PRODUCTS**	CHEMISTRY FOR THE CONSUMER **(NS)**	MATERIALS WE USE **(NS)**
Theme C **TECHNOLOGY AT WORK**	USING SYSTEMS AND TECHNOLOGIES **(ST)**	TECHNOLOGY IN TRANSPORTATION **(ST)**
Theme D **UNDERSTANDING OUR ENVIRONMENT**	MANAGING ENVIRONMENT AND RESOURCES **(STS)**	ENERGY AND THE ENVIRONMENT **(STS)**

(NS)	Nature of Science
(ST)	Science and Technology
(STS)	Science/Technology and Societal Issues

INTERPERSONAL SKILLS AND THE SOCIAL SPHERE

High school represents a transitional stage of life for students as they develop the ability to use adult skills. For some students, it may be a time of uncertainty as they strive for independence, yet, at the same time, experience pressures from parents, peers, media and themselves. Response to these pressures may be inconsistent as students continue to develop reflective awareness and the ability to analyze their emotions.

Although schools are not the sole influences on a student's emotional, social and ethical behaviour, the instructional program does affect interpersonal learning.

The Goals of Secondary Education directly state the importance of affective and interpersonal goals when they indicate that students should:

- learn about themselves and develop positive, realistic self-images
- develop constructive relationships with others based on respect, trust, cooperation, consideration and caring as one aspect of moral and ethical behaviour.

Students will vary in their emotional/social development and their ability to cope with personal problems. Behaviours viewed as "problematic" are often simply an indication of a student's lack of sophistication in using adult skills. Classroom instruction must provide a variety of approaches that will encourage students to reflect upon their responses in social situations and to develop productive interpersonal skills. The guidelines that follow have been adapted from Alberta Education's monograph *Students' Interactions: The Social Sphere* (1988), and are intended to foster affective, interpersonal and moral learning within the classroom:

- Students imitate and thereby implicitly learn to deal with emotions, other people and ethical issues by observing the consistency of adult behaviour. Therefore, it is important that appropriate behaviour be modelled for students. When teachers are respectful of students' dignity, students will respond positively.
- Encourage students to express their opinions and feelings, to ask questions and to accept emotions as they occur in day-to-day life. Through mediated learning (see "Instructional Mediation"), encourage students to examine emotional responses from different frames of reference, and to organize and interpret their own responses as well as the responses of others.
- Provide students with supportive comments, guidance and genuine expressions of concern. Set expectations that are firm and fair, and then believe in the students' ability to meet these expectations and do well. Develop "working agreements" to help tasks flow smoothly, and to ensure that students understand the nature of the instructional tasks they are asked to perform.
- Ensure that classroom management practices and rules are known, upheld, moderate in nature, negotiable, and consistently applied. Responding to the harmful or unjust effects/consequences of a moral transgression is more effective than reference to broken rules or unfulfilled social conventions.
- Recognize that experiential learning is a particularly effective vehicle for teaching interpersonal skills. Although some learning may occur through listening and reading, one best learns to live with other people by living with other people. Cooperative learning techniques are especially useful where students are actively involved in lessons linked to their own needs, interests or experiences.

- Be aware that although teenagers deal with a number of issues, these issues usually come into focus at different times. The issues are not so interdependent that the solution of one of them requires prior solution of others. Help students to integrate various aspects of their lives by encouraging them to recognize how various problems/issues/solutions are often interrelated.

- Assist students to learn skills that are appropriate in differing contexts. Although some students are described as "lacking in social skills", socially maladapted students do not necessarily lack "either skills" or social involvement; rather, they use inappropriate skills in particular contexts. When directly teaching interpersonal skills, be as concrete as possible, and "build bridges" by linking situations with appropriate actions and behaviours.

- Assist students to focus on the need for a system of shared conventions. As students affirm the social system of conventions, they will view conventions more positively and will become less disruptive in their behaviour.

- Encourage students to interpret and evaluate ethical issues presented to them. Provide opportunities for open discussion and debate, where students interact with their peers. Discuss issues that are "real" to the student.

- Provide students with practical strategies for resolving interpersonal conflict. A framework for social problem solving is provided in the *Teacher Resource Manual.* This framework uses a problem-solving approach in helping students to identify:
  - reasons for the difficulty
  - strategies to avoid the conflict another time.

Student development in the affective and interpersonal domains has been addressed in this curriculum through attitudinal learning objectives that accompany each cluster of concepts and skills in the Program of Studies. Instruction must include a balance of approaches appropriate to student development in each domain, as delivery of isolated content will not ensure the formation of desired attitudes. The *Teacher Resource Manual* provides additional strategies that facilitate attitudinal development within the context of themes suggested in the program.

REQUIRED AND ELECTIVE COMPONENTS

The required component of the Science 16-26 Program reflects the concepts, skills and attitudes that all students must acquire. Content for the required component has been selected on the basis of its broad application and frequent use in everyday situations. The Program of Studies outlines the required component of the program.

The elective component of Science 16-26 permits the teacher to:

- **remediate** or **reinforce** concepts/skills within the required component of the program. Student needs may suggest that the elective component be used to enhance the learning process within particular content areas of the required component.
- **extend** or **enrich** the program by way of introducing additional concepts, skills and attitudes considered appropriate to student interest and need.

Students' abilities, interests and needs will largely determine how the elective time will be used. The elective component provides opportunities for varying organizational and instructional strategies that facilitate learning and that are appropriate to each student's developmental stage and preferred way of learning.

The instructional time for Science 16-26 should be apportioned:

- 80% Required
- 20% Elective.

In keeping with the philosophy that concepts, skills and attitudes are more successfully learned if taught within relevant contexts, they have been integrated into four themes at each grade level. Utilizing all four themes will ensure coverage of the required component. The "Planning" section of this document provides general guidelines and ideas for adapting themes to the particular circumstances of the classroom and individual students.

SUGGESTIONS FOR THE ELECTIVE COMPONENT

Several factors must be considered in planning content and activities for the elective component:

- student ability/interest/need
- curriculum goals and philosophy
- availability of learning resources/support materials.

For most students and classes, the elective component will be used in providing additional instructional time (extension and remediation) for study of the four themes that support the required portion of the program. In other instances, however, teachers may wish to enrich their program through the study of optional content. Optional content may involve the student in the study of:

- specific science competencies required in an occupational course
- a topic of personal interest or need
- a topic of significance to the local community.

"Suggested Options" for the Science 16-26 program have been provided in this document as a service to teachers. Teachers may choose to offer one or more of the options suggested below, or develop other topics considered appropriate to student interest and need.

SUGGESTED OPTIONS FOR SCIENCE 16-26

SCIENCE IN AN OCCUPATION:

- Food and Microbes

PERSONAL INTEREST OR NEED:

- Using Light and Sound

There is no requirement that optional content be included in the science program. However, if optional content is developed, teachers must ensure that such content:

- supports the general learning objectives identified for the science program (see "Model for the Science 16 Program")
- does not detract from the achievement of specific learning objectives within the required component of the program.

PLANNING

GENERAL COURSE PLANNING

Themes and their subsequent concepts, skills and attitudes may be sequenced at the teacher's discretion. Program planning should take into consideration the developmental nature of concepts and skills in science, as well as students' interests, abilities, and preferred ways of learning. Four themes that cover the required components of the program have been provided in the *Teacher Resource Manual*. These themes are intended to be descriptive rather than prescriptive, and may need to be modified in addressing individual student needs.

Through cooperative conferencing, teachers may find that students are required to use certain science-related competencies in other courses before they are learned in science class. Joint planning and negotiation with teachers of other courses will be required in establishing an integrated program that places consistent expectations upon the student.

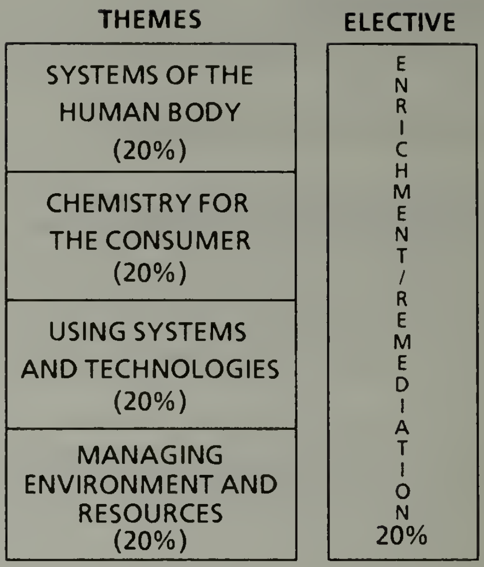
Program planning should emphasize the nature of science, as well as an understanding of the role of science and technology in society. Activities must support the development of thinking skills, and provide students with opportunities to develop appropriate strategies and skills for inquiry, problem solving and decision making. The activities suggested throughout both the *Program of Studies/Curriculum Guide* and *Teacher Resource Manual* are numerous, but by no means exhaustive. Teacher use of these ideas will depend upon their appropriateness in meeting individual student needs. **Be prepared to add, delete, and modify activities in adapting a theme to the particular circumstances of the classroom and student.**

TIME ALLOCATION

As a 3-credit course, Science 16 is designed to be taught through 75 hours of instruction. In meeting student needs, however, schools may find it desirable to offer this 3-credit course through 125 hours of instruction.

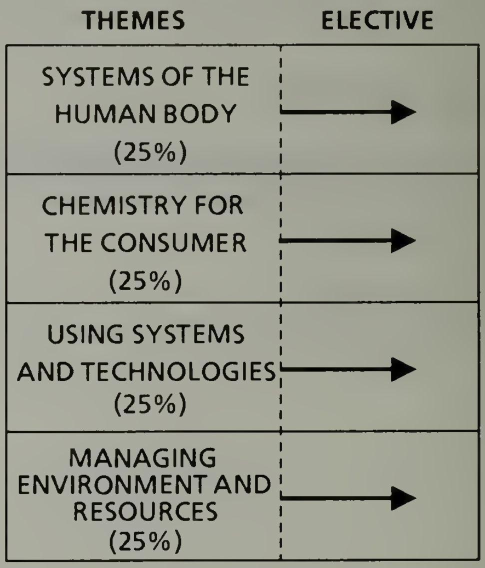
Minimum time allocations are recommended for the delivery of themes outlined in the *Teacher Resource Manual*. These recommendations are intended to provide guidance for the teacher.

Systems of the Human Body	20%
Chemistry for the Consumer	20%
Using Systems and Technologies	20%
Managing Environment and Resources	20%
Required Time	80%
Elective Time	20%
Total	100%


THEMES
ELECTIVE
SYSTEMS OF THE HUMAN BODY (20%)
CHEMISTRY FOR THE CONSUMER (20%)
USING SYSTEMS AND TECHNOLOGIES (20%)
MANAGING ENVIRONMENT AND RESOURCES (20%)
ENRICHMENT/REMEDIATION
20%

If student needs suggest that the elective component be used to provide additional instructional time (extension and remediation) for study of the four themes that support the required component of the program, time allocations for each theme might be increased to those indicated below.

Systems of the Human Body	25%
Chemistry for the Consumer	25%
Using Systems and Technologies	25%
Managing Environment and Resources	25%
Total	100%


THEMES
ELECTIVE
SYSTEMS OF THE HUMAN BODY (25%)
CHEMISTRY FOR THE CONSUMER (25%)
USING SYSTEMS AND TECHNOLOGIES (25%)
MANAGING ENVIRONMENT AND RESOURCES (25%)

Teachers may find it desirable to plan programs using time allocations that fall between those described in these two alternatives.

COMMUNITY PARTNERSHIPS

The science program must enable students to recognize the relevance of scientific knowledge in daily life experiences within the home, community and work environments. Within this context, students will be expected to demonstrate competencies that will enable them to:

- apply scientific concepts and skills to practical situations
- set goals, solve problems and make informed decisions
- prepare for a chosen occupation or career.

Community partnerships (i.e., community-based learning experiences) will foster an appreciation of science for its usefulness and relevance, and will assist students to relate specific concepts and skills to personal experiences in everyday life and the world of work. Guest speakers, field trips, job shadowing and mentorship are but a few examples of inviting members of your community into the class, or having students involved in the community by way of meaningful activity linked to science. Partnerships of this nature provide additional opportunities for students to raise questions, collect data and investigate issues in the local community.

Relevant community partnerships for Science 16 may include:

- inviting guest speakers from government, business, the professions and the trades to discuss topics that relate to each theme of investigation

- visiting local business and industry for first-hand observation of a variety of technologies and skills in use

- investigating career and employment opportunities in areas related to each theme studied in the science program (e.g., job shadowing, analysis of skills required, mock employment interviews).

Community groups or facilities that lend themselves particularly well to partnerships with the science program include:

- service groups that promote personal and environmental health (e.g., doctors, nurses, nutritionists, pharmacists, social workers, police officers, agriculturalists, wildlife officers)

- government officials (e.g., councillors, MLA's)

- local businesses and industries that make application of the concepts and skills studied in science (e.g., hair care, dry cleaning, automotives, agriculture, food preparation, construction, electrical repair)

- local utility plants (e.g., power generating plants, sewage treatment plants, water purification plants, waste disposal sites)

- natural phenomena (e.g., local river valley, meadow, or wooded area).

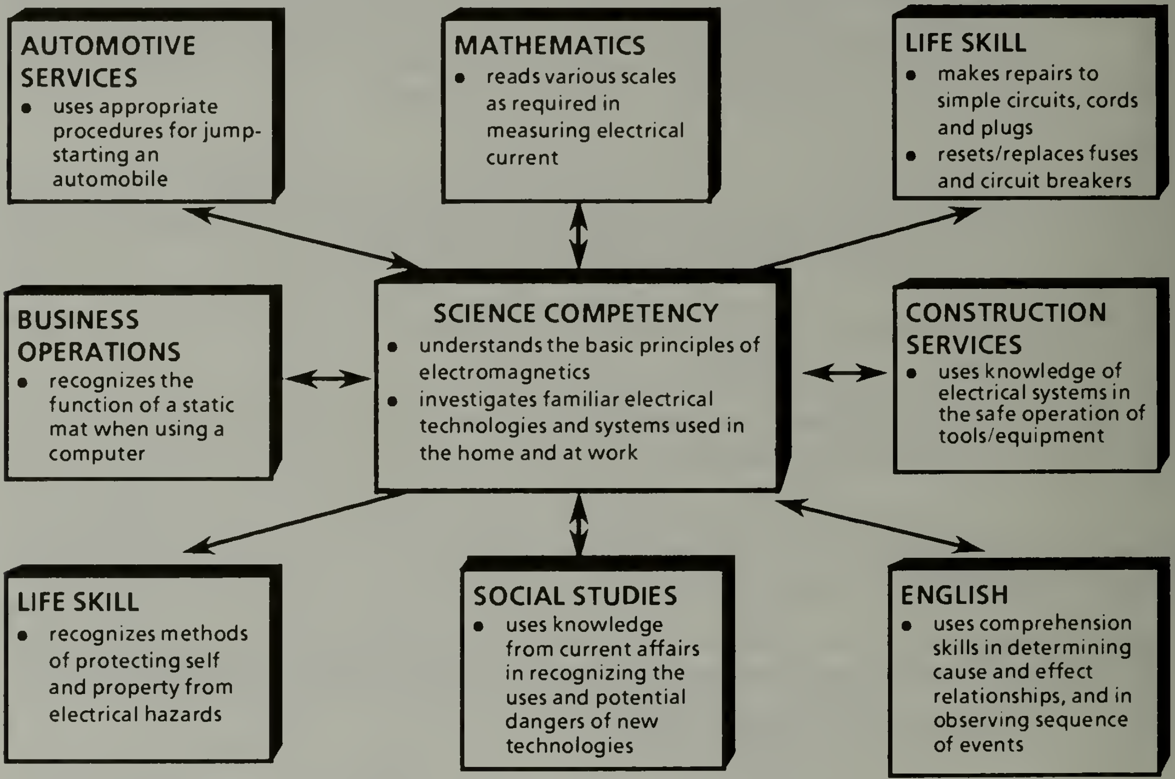
Additional suggestions as to how community partnerships can be meaningfully linked with instruction in science are provided throughout each theme of the program.

CURRICULAR INTEGRATION

The science program facilitates the development of effective problem-solving and decision-making behaviours by providing learning experiences that reflect and build upon the demands of home and school. Program content is developed within the context of its application to daily living, the occupational program and other academic disciplines. The integration of curricular content with contexts for application facilitates the transfer of specific concepts, skills and attitudes to more generalized situations, and serves as a motivating factor when students recognize the relevance of their learning experiences.

Teachers must be familiar with science competencies required of students in everyday life, the occupational program and other academic disciplines. Cooperative planning and conferencing with other teachers is central to understanding the contexts in which concepts and skills are used, and will assist teachers in providing practical and relevant learning experiences that facilitate the transfer of knowledge and skill.

EXAMPLES OF CURRICULAR INTEGRATION BASED ON A SCIENCE COMPETENCY


AUTOMOTIVE SERVICES
• uses appropriate procedures for jump-starting an automobile
MATHEMATICS
• reads various scales as required in measuring electrical current
LIFE SKILL
• makes repairs to simple circuits, cords and plugs
• resets/replaces fuses and circuit breakers
BUSINESS OPERATIONS
• recognizes the function of a static mat when using a computer
SCIENCE COMPETENCY
• understands the basic principles of electromagnetics
• investigates familiar electrical technologies and systems used in the home and at work
CONSTRUCTION SERVICES
• uses knowledge of electrical systems in the safe operation of tools/equipment
LIFE SKILL
• recognizes methods of protecting self and property from electrical hazards
SOCIAL STUDIES
• uses knowledge from current affairs in recognizing the uses and potential dangers of new technologies
ENGLISH
• uses comprehension skills in determining cause and effect relationships, and in observing sequence of events

Basic principles governing the operation of electromagnetic systems are developed in science and related to their applications in other areas. Subject areas across the curriculum will maintain and reinforce specific concepts and skills related to electromagnetics as they are used within each discipline. While in this instance application is shown in all subject areas, some competencies may have a more limited range of applications.

The Program of Studies/Presentation of Content section of this document facilitates curricular integration by relating science competencies to daily life skills (Column 2) and to other applications across the curriculum (Column 3). The *Teacher Resource Manual* provides further opportunities for developing science competencies within the context of their application to other subject areas (see "Integration Activities").

PLANNING AN INTEGRATED UNIT OF INSTRUCTION

A variety of factors need to be considered when expanding upon an existing theme or developing a new thematic unit. The guidelines that follow provide structure and direction for developing units of instruction.

1. Identify a possible theme, based on:
   - curriculum goals and objectives
   - student needs/interests/abilities
   - availability of suitable learning resources.

2. Develop a purpose for the theme. Include:
   - thematic objectives
   - a checklist of concepts, skills and attitudes that lend themselves to the theme. Identify those skills that may need some focused/direct teaching.

3. Consider suitable resources:
   - books, pamphlets, monographs
   - appropriate laboratory equipment
   - computer software, films, videos
   - resources from the occupational program
   - community resources
   - newspapers and periodicals
   - other resources that students may have access to.

4. Design activities:
   - allocate activities to the purposes developed in Step 2
   - develop a checklist of process objectives to be emphasized in the theme
   - break activities into lessons with general objectives
   - sequence the lessons.

5. Develop ongoing strategies to build community partnerships into your theme:
   - field trips
   - guest speakers.

6. Plan for evaluation:
   - students' evaluation
   - teacher ongoing (formative) and summative evaluation.

7. Share the unit:
   - other teachers need access to good work!
   - keep notes, reflect, expand and rework the unit each time it is used
   - as others experiment and your unit enlarges, develop a mechanism for evaluating activities with different classes of students.

LEARNING RESOURCES FOR SCIENCE 16

STUDENT RESOURCES

BASIC LEARNING RESOURCES

The learning resources listed below address the majority of the goals and learning objectives identified in this *Program of Studies/Curriculum Guide*. Because of the modular format of the learning resources, they have been listed separately for each theme within the science program.

Theme A: Systems of the Human Body

Hutton, Glen, ed. *Your Body in Balance*. ISIS Individualized Science Instructional System (Booklet). Revised. Scarborough, Ontario: Globe/Modern Curriculum Press, 1989.

Theme B: Chemistry for the Consumer

Hutton, Glen, ed. *Household Science*. ISIS Individualized Science Instructional System (Booklet). Revised. Scarborough, Ontario: Globe/Modern Curriculum Press, 1989.

Theme C: Using Systems and Technologies

Hutton, Glen, ed. *Science, Technology, and You*. ISIS Individualized Science Instructional System (Booklet). Revised. Scarborough, Ontario: Globe/Modern Curriculum Press, 1989.

Theme D: Managing Environment and Resources

Hutton, Glen, ed. *Investigating the Environment*. ISIS Individualized Science Instructional System (Booklet). Revised. Scarborough, Ontario: Globe/Modern Curriculum Press, 1989.

SUPPORT LEARNING RESOURCES

The learning resources listed below assist in addressing some of the learning objectives identified in this *Program of Studies/Curriculum Guide*. Because of the modular format of the learning resources, they have been listed separately for each theme. Multiple copies (but not necessarily class sets) of each resource may be desired.

Theme A: Systems of the Human Body

Mooney, Libby and Andy Rivers. *Body Maintenance*. Science at Work Series, Third Edition (Booklet). Harlow, England: Longman Group Limited, 1989.

Theme B: Chemistry for the Consumer

Wilshaw, Chris and Paul Wright. *Cosmetics*. Science at Work Series, Third Edition (Booklet). Harlow, England: Longman Group Limited, 1989.

Theme C: Using Systems and Technologies

Taylor, John. *Gears and Gearing*. Science at Work Series (Booklet). Harlow, England: Longman Group Limited, 1985 (new edition pending).

Theme D: Managing Environment and Resources

Rowlands, David. *Pollution*. Science at Work Series, Third Edition (Booklet). Harlow, England: Longman Group Limited, 1989.

OTHER LEARNING RESOURCES

A listing of other student learning resources identified as useful in implementing the Science 16 Program, but which have not undergone the standard review procedures of Alberta Education is provided in the *Teacher Resource Manual*. The responsibility for evaluating these resources prior to selection and use rests with the local jurisdiction.

TEACHER RESOURCES

The teacher support document listed below is designed to assist classroom teachers to implement the Integrated Occupational Science 16 Program. The document provides teaching strategies and sample activities that structure the development of concepts, skills and attitudes outlined in the Program of Studies, and supports thematic delivery of the science program.

Alberta Education. *Science 16 Teacher Resource Manual*. Edmonton, Alberta: Alberta Education, 1990.

The teacher guide listed below is designed to assist classroom teachers in using the basic learning resources.

Hutton, Glen, ed. *ISIS Individualized Science Instructional System Teacher Resource Guide*. Revised. Scarborough, Ontario: Globe/Modern Curriculum Press, 1989.

The safety resource book identified below will assist teachers in establishing appropriate safety procedures for the science program.

Science Education Consultants. *Safety and Organization in School Science Facilities* (Second Edition). Edmonton, Alberta: Alberta Education, 1986.

Other teacher resources that may be useful in implementing the Science 16 Program are identified in the *Teacher Resource Manual*.

TECHNOLOGY AND MEDIA

An annotated list of computer software that may be useful in supporting curriculum objectives identified in this *Program of Studies/Curriculum Guide* is provided in Alberta Education's catalogue of *Computer Courseware Evaluations* (Curriculum Support Branch, Student Programs and Evaluation Division, Alberta Education, 1986) and annual supplements.

There is a growing collection of media resources (e.g., films, videotapes, kits, pamphlets) that support the development of specific learning objectives within the science program. A listing of media resources identified as useful in implementing Science 16 is provided in the *Teacher Resource Manual*. Teachers may wish to obtain these and other audio-visual materials considered appropriate to the science program by contacting local media services, libraries and government agencies.

ACCESS NETWORK

ACCESS offers a variety of resources and services to teachers. For a nominal dubbing and tape fee, teachers may have ACCESS audio and video library tapes copied. ACCESS also offers a service called "Night Owl Dubbing". This allows educators to tape late night educational programs directly from their own televisions.

ACCESS publishes both an *Audio-Visual Catalogue* and a comprehensive schedule of programming, available on request.

For additional information, contact ACCESS NETWORK, Media Resource Centre, 295 Midpark Way SE, Calgary, Alberta, T2X 2A8 (from outside of Calgary, telephone toll free, 1-800-352-8293; in Calgary, telephone 256-1100).

REGIONAL RESOURCE LIBRARIES

Films and videos are available for loan through the five centres listed below. In some instances, computer software is also loaned. Catalogues of holdings are available upon request.

Zone I	Zone One Regional Film Centre P.O. Box 6536 / 10020 – 101 Street Peace River, Alberta T8S 1S3 Telephone: 624-3187
Zones II and III	Central Alberta Media Service (CAMS) 2017 Brentwood Boulevard Sherwood Park, Alberta T8A 0X2 Telephone: 464-5540 / 467-8896

Zone IV
Alberta Central Regional Education Services (ACRES)
County of Lacombe No. 14
Box 3220 / 5140 – 49 Street
Lacombe, Alberta
T0C 1S0
Telephone: 782-5730

Zone V
South Central Alberta Film Federation (SCAFF)
Westmount School
Box 90 / Wheatland Trail
Strathmore, Alberta
T0J 2H0
Telephone: 934-5028

Zone VI
Southern Alberta Regional Film Centre (SCARFC)
c/o McNally School
P.O. Box 845
Lethbridge, Alberta
T1J 3Z8
Telephone: 320-7807

METHODOLOGY

WORKING WITH THE RELUCTANT LEARNER

All students are capable of successful learning experiences in science. Students differ, however, in their rate and style of learning, as well as in the degree of support and encouragement required. Previous experiences, perceptions of the value of science, and the fear of being wrong or making a mistake are all factors that may cause students to look upon the science classroom as a place where personal inabilities are exposed. **A supportive learning environment will assist students in dealing with these attitudes. In order to meet the interests and abilities of individual students, the program must be varied in materials, content, pace and instructional methods.**

Guidelines for establishing a supportive learning environment that facilitates attitudinal development are provided in the "Interpersonal Skills and Social Sphere" section of this document. Additional strategies that may be useful in decreasing anxiety levels and building appropriate attitudes within the science classroom are provided through the following suggestions:

- Become familiar with the learning characteristics (e.g., reading level, interests, preferred learning style) of individual students through background information, interviews and direct observation.

- Choose topics for investigation that are relevant to everyday life. Be aware that students are concerned with the immediate and practical effects of science. Relate concepts and skills studied to personal experience. Make an effort to ensure that terminology commonly used is part of the students' working vocabulary. Focus attention on what students consider interesting or important. Familiar problems/issues will "make sense" more readily than unfamiliar ones.

- Provide abundant opportunities for learning at the concrete level. Plan activities that emphasize a "hands-on" and multi-sensory approach to the learning of science. Encourage students to verbalize and discuss the relationships that are discovered. Assist students to transfer and apply relationships discovered to a variety of related life situations.

- Avoid unnecessary tension in the classroom by being patient, receptive and understanding. Ensure that students recognize that making a mistake is acceptable, and that such occurrences provide valuable learning experiences. Urge students to ask questions, and to accept that "there is no such thing as a stupid question". Remember that an offhand remark about a question being "easy" may be interpreted by a student as "If it's easy and I'm confused, then I must be stupid". Recognize and accept alternative interpretations/explanations that students may formulate.

- Match the reading level of resources and materials used to that of the students. Provide assistance and support in developing necessary science vocabulary. Steps should be taken to ensure that reading deficiencies do not prevent students from learning science.

- Group for instruction through a variety of organizational patterns that will facilitate meeting the needs of individual students. Ensure that grouping patterns remain flexible, allowing student movement from group to group. Include learning activities that require whole group, small group, and one-to-one (teacher to student and/or student to student) involvement. Use such resources as the buddy system, peer tutoring and aides.

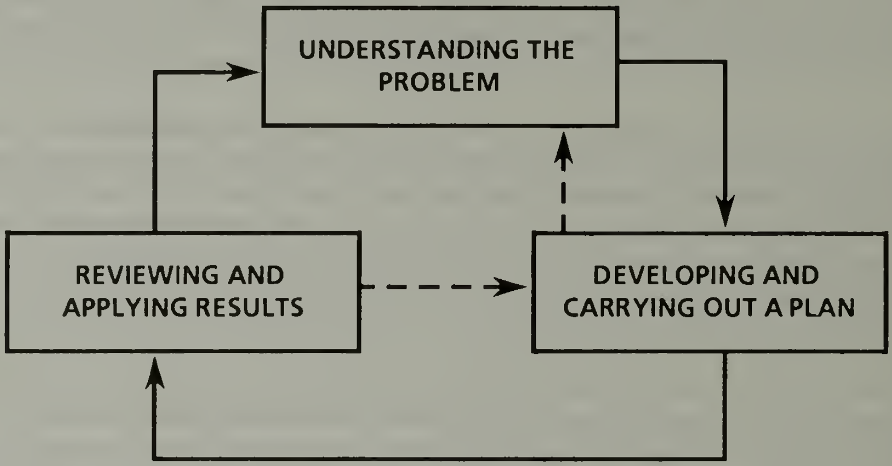
- Ensure that investigative activities are well structured, recognizing the organizational problems and language deficiencies that some students may have. Provide students with direction when gathering data for investigation. After the data has been gathered, leading questions may be used to guide students in making a reasonable interpretation and evaluation of the results. Encourage students to discuss their results with other members of the class. Students should be led to suggest ways of resolving differences in data collected or in the interpretation of results.

- Use a variety of assessment and evaluation strategies. While paper-and-pencil tests are an effective way of evaluating some learning outcomes, their use does not always enable students to demonstrate gains made. Provide opportunities for students to demonstrate acquired knowledge and skills in a variety of ways. Effective evaluation should draw upon information gathered through teacher observation, student demonstration and project work. Additional strategies for student evaluation are provided in the section entitled "Evaluation".

- Recognize that while most attitudinal problems are brought about through past experiences that may foster natural apprehension of new or challenging situations, there are other emotional symptoms that may be related to deeper personal or social problems. Personal interviews with students will assist in identifying such instances, and may also establish a need for consultation (or referral) with counsellors who have expertise in dealing with such problems.

A FRAMEWORK FOR CONDUCTING INVESTIGATIONS IN SCIENCE

A framework for inquiry and problem solving is diagrammed below. Although the framework provides an overall structure that can help students to understand the processes used in conducting an investigation, it should not be interpreted as a series of fixed and rigid stages and strategies. There are many ways to approach a problem, and the sequence of steps used will depend upon individual problems and individual students. Students may not always go through the steps in the order suggested, nor even use all steps in some problem situations. Nevertheless, students should recognize that solving problems involves a series of interrelated actions that lead to an outcome or solution.


UNDERSTANDING THE PROBLEM
REVIEWING AND APPLYING RESULTS
DEVELOPING AND CARRYING OUT A PLAN

The framework for problem solving in science parallels the framework used for conducting investigations and solving problems in other subject areas within the Integrated Occupational Program. The framework provides a general "plan for action" that can guide students through a broad range of investigative activities (e.g., problem solving, troubleshooting, inquiry, decision making, library research). As students become familiar with the framework and discern similarities among the actions taken in different forms of investigation, they will become more likely to transfer skills learned in specific contexts to more generalized situations where methods and outcomes may be uncertain. Students should recognize how the framework for conducting investigations in science provides a general plan for action that is also effective in guiding investigations in English, mathematics, social studies and the occupational program, and how specific skills used at each stage within the framework will vary according to the nature of the problem or investigation.

Student ability to conduct investigations and solve problems can be enhanced by making students conscious of their thought process (i.e., metacognitive awareness). Students need to become aware of and discuss how they think in order to become more strategic in their learning repertoires and to monitor their own efforts. Research strongly supports the teaching practice of:

- modelling (talking through) the processes and skills that are appropriate to an investigation
- discussing the processes and skills that the student is presently in the habit of using (i.e., raising the level of metacognitive awareness)
- encouraging students to develop additional strategies that will structure and support the thought process.

Questioning and modelling techniques that might be used to guide students in thinking about problems and in developing effective problem-solving strategies are provided in an ensuing section of this document (see "Instructional Mediation").

SUGGESTIONS FOR USING THE FRAMEWORK

Critical to the development of thinking skills is the attitude with which students approach situations where methods may be uncertain and outcomes are unknown. The development of appropriate attitudes must be nurtured through an atmosphere that fosters flexibility and acceptance. Students must learn to accept and appreciate that being perplexed and unsure is often normal when first encountering a challenging situation, and to take risks in the development of particular problem-solving strategies. The guidelines that follow may assist teachers in planning instructional activities that support the development of effective thinking skills.

- Create a positive classroom atmosphere. Foster the development of attitudes and behaviours that promote student thinking and ability to monitor progress through an investigation by:

    - encouraging students to be creative, and to generate their own ideas and approaches to gathering information and solving problems
    - providing adequate support and assistance to students, but not solving their problems for them
    - being willing to accept unconventional strategies and solutions
    - challenging students to think critically and justify strategies and solutions
    - being enthusiastic and capable of recognizing the students' desire and perseverance in conducting investigations.

- Share the framework for conducting investigations with students. The framework provides a structure for thought and action, and will enable students to discern similarities among skills that are used in different kinds of investigation.

- Assist students to become aware of a variety of thinking skills and thought processes that are useful in conducting inquiry, solving problems and making decisions. Ask questions that encourage students to discover their own answers, and model (talk through) complete thought processes that are used in different kinds of investigation.

- Encourage students to recognize how the framework for conducting investigations in science provides a general plan for action that is also effective in guiding investigations in English, mathematics, social studies and the occupational program, and how specific skills used at each stage within the framework may vary according to the nature of the problem or investigation.

- Keep the framework and strategies for conducting investigations flexible and tentative. While the framework is useful in the structure it provides, students should be encouraged to be creative and experimental in their approach to solving problems.

- Ensure that investigations do not become tedious or unrealistically complex. Data related to the phenomena investigated must be readily available. Cognitive demands of the situation must match the developmental levels of students.

- Select investigations emerging from everyday life that are relevant to the interests and experiences of students. Provide opportunities for students to gather data related to local issues through a variety of methods (e.g., reading, viewing, interviewing), and to consider current perspectives on issues as reflected through local media (e.g., newspapers, periodicals, television, radio).

INSTRUCTIONAL MEDIATION

A great deal of recent research has focused on instructional mediation and "teacher talk" in the classroom. Instructional mediation is an interactive process whereby teachers refine their interpretation of tasks to students, as students construct their own interpretations of the tasks and processes being learned. This back and forth exchange stimulates the development of thinking skills by allowing both sides to contribute to a meaningful learning situation. Lectures, or one-sided explanations, rely on students to be "self-mediating" and to supply their own meaning to processes. Most students can benefit from further practice in this area.

Instructional mediation regulates the students' behaviour in terms of the use of strategies and approach to tasks. Emphasis on a strategic view of tasks will encourage students to become independent in the tasks they perform and the processes they use. For example, a strategy for conducting scientific inquiry will enable more students to perform investigations on their own. In addition, such a strategy enables the student to identify for the teacher at what point they need assistance, if they are unable to completely solve the problem.

A further use of mediation is in developing the students' feeling of competency. Students need to see themselves as competent and able to do things. Students who feel competent, and who recognize their effort as being effective in learning, are more likely to be persistent in attempting new tasks that are difficult. On the other hand, students who require frequent praise for their effort come to have limited performance goals and are hesitant to engage in any task at which they cannot quickly become successful. Teachers can encourage students to extend their learning goals by focusing mediation on the role of effort and strategy in achieving success.

In creating a classroom environment that will stimulate strategic behaviour and thinking skill, the teacher should:

- point out, but not correct errors
- encourage students to correct their own errors
- pause and clarify, but not interrupt
- demand constant vocalization of student thought processes that are used, and model these for students
- encourage persistence through praise.

The mediation process can also be enhanced through the use of appropriate "questioning techniques" and the "modelling" of complete processes and thought patterns. These instructional methods are described in the paragraphs that follow.

QUESTIONING TECHNIQUES

Questioning techniques should include the use of chains of questions that lead students to discover their own answers. Question chains should begin with focus questions such as:

- What are we looking for?
- What do we want to explain/investigate?
- What do you think might happen if . . . ?
- Why did . . . ?
- What should we do first?
- What is stopping us?

Once students have focused on the significant pieces of information, questioning is expanded to include:

- What is my next step?
- How will I do that?
- What is the relationship between . . . and . . . ?
- How are . . . and . . . related?
- Why did . . . happen after . . . ?
- What is the likelihood that . . . ?
- What do you notice about . . . ?

Students should be encouraged to evaluate the thought processes used in completing individual tasks and the problem-solving process. Questions asked may include:

- How did you know that . . . ?
- What does the data indicate?
- What caused . . . to happen?
- How does . . . apply to . . . ?
- How could you explain . . . in another way?
- How might you use these results?
- How could we make our work easier another time?
- What should we tell others?

Questions that probe and prompt students to process information, rather than fixate at the simple recall level, will make students aware that they are expected to be actively involved in thinking processes. When students experience success with investigation through use of the teacher's questioning chain, they will discover the importance of the thought processes used, and be encouraged to develop personal strategies that direct their efforts in related tasks.

COGNITIVE MODELLING

Cognitive modelling, as opposed to demonstrating, involves "talking through" a complete process in order to expose thinking processes to the student. While in a demonstration everything turns out as it should, modelling should include false starts, trouble spots, and errors. This type of modelling requires teachers to express their thinking processes out loud so that students can see not only how the process is done, but also how difficulties and ambiguities are addressed. As the process is modelled, students should recognize that the teacher's approach may not necessarily be the "best" approach, but simply one way of tackling the problem.

While teachers often model when explaining processes and problems, knowledge and awareness of the value of modelling can serve to sharpen this process. Asking students where they might begin to solve a problem makes a good starting point. If the reply is "I don't know", an area of difficulty is determined. The mini-processes of "understanding the problem" and "developing a plan" might then be modelled for students.

SAFETY IN SCIENCE

Safety must be a major consideration as students become actively involved in experimental procedures and laboratory settings. An awareness of safety should be developed through a common sense approach. Students should recognize that specific hazards can be avoided through advance planning and an awareness of hazardous materials and situations. No laboratory work should be expected of students if they are not fully aware of possible hazards and preventative measures.

When conducting experiments and investigations, students will be expected to display a concern for safety by:

- following directions exactly as given
- understanding the import of what they are doing
- maintaining order and neatness when using equipment
- using prior knowledge to make judgments
- asking for advice when in doubt.

Students should be encouraged to transfer the safety knowledge and attitudes developed in school to potentially dangerous situations they may encounter at home, at work and in the community.

RESPONSIBILITIES OF THE TEACHER

Teachers must provide adequate supervision of students at all times, and emphasize accident prevention. Students must be alerted to situations they may create that are unsafe or hazardous.

The most effective method of teaching safety is by example. The procedures and attitudes modelled by the teacher influence students more than actually teaching a unit on safety. The teacher must be conscious of the example being set, and through modelling assist students to develop appropriate safety habits and attitudes, including:

- careful observation and alertness at all times
- application of safety procedures and techniques
- advance identification of safety responsibilities associated with experimental procedures that are planned.

RESPONSIBILITIES OF THE STUDENT

Students must be alerted to general safety precautions and procedures early in the science program. Specific hazards and precautions related to the use of equipment and chemicals must be discussed as the materials are used. Students should learn to plan their laboratory investigations and procedures in ways that will minimize the possibility of accidents. All accidents and unexpected events that occur should be reported and discussed with the teacher.

It is advised that a **Student Safety Contract** be issued early in the school year, after students have been alerted to general safety precautions and procedures. Use of a safety contract will increase the students' awareness of personal responsibilities in the safety of self and others. A sample student safety contract is provided in the *Teacher Resource Manual*.

SAFETY GUIDELINES AND POLICIES

Teachers must be familiar with safety policies and statements adopted by their employing board. In the absence of such statements, teachers should be aware of specific hazards that students face in the science program and take suitable precautions to avoid such hazards.

Teachers must also be familiar with policy and information provided in Alberta Education's monograph *Clarification of Statements Prohibiting the Use of Human Body Substances in the Alberta Science Curriculum*, 1988. (Due to the potential risk of infection from hepatitis and AIDS, all activities involving the extraction and analysis of samples of human fluid or tissue are prohibited in Alberta schools.)

Additional safety information is provided in:

- *Safety and Organization in School Science Facilities*, a resource book for elementary and secondary schools by Science Education Consultants, Alberta Education, 1988.

- *Hazardous Chemicals: Information and Disposal*, a resource by Margaret-Ann Armour, Lois Browne and Gordon Weir, published by the University of Alberta, Edmonton, 1985.

WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM

The Workplace Hazardous Materials Information System (WHMIS) is a hazard communications program designed to protect workers across Canada from injuries and illnesses caused by exposure to chemicals. The program uses federal and provincial legislation to ensure:

- the labelling of hazardous materials
- the provision of material safety data sheets (MSD's) by suppliers of hazardous materials
- worker education/instruction programs.

WHMIS provides a way for teachers to obtain information about hazardous materials that may be used in the science program. Science teachers should consult WHMIS in order to identify the hazards of various materials and the precautions to take when using these materials. Additionally, all secondary school students should receive instruction about WHMIS, and use the system in their work. WHMIS instruction is probably of greatest value at opportune times before and during students' use of controlled products, rather than as an individual topic of study.

Policy and information on WHMIS is provided in *WHMIS: Abridged Guidelines for Schools*, a resource booklet prepared by the Science Education Consultants' Council, Alberta Education, 1989. Posters, booklets and pamphlets that describe features of WHMIS are available at no cost from the nearest Regional Office of Alberta Occupational Health and Safety.

Other resource materials on WHMIS include a videotape *WHMIS: Working for You* and a reference manual *WHMIS Core Material: A Resource Manual for the Application and Implementation of WHMIS (1989 Revised Edition)*. These materials can be ordered through the Alberta Association of Safety Personnel/Canadian Society of Safety Engineers Provincial Body at the address provided below.

AASP/CSSE Provincial Body
P.O. Box 262, Main Post Office
Edmonton, Alberta
T5J 2J1

USING TECHNOLOGY AND MEDIA IN SCIENCE CLASS

USING TECHNOLOGY

An understanding of the impact and use of technology is essential in preparing students for current and future demands in society. Instructional activities should focus attention on various aspects of technology by providing opportunities for students to:

- learn about technology. Students should develop an awareness of the advantages and limitations of particular technological developments and their impact upon society
- learn with technology. Students should develop the ability to use selected technologies as tools to get work done or as an aid to problem solving (e.g., the hand-held calculator)
- learn through technology. This aspect refers to the use of selected technologies to enhance learning (e.g., computer-based instruction, computer-assisted learning).

In preparing students for future roles in society, one must recognize the increasing importance of being able to interact with computer technology. To the extent that computer facilities and equipment are available, the science program must provide opportunities for students to develop knowledge and skills in the use of computer technology, including:

- an understanding of the basic operation of computers
- an ability to work independently with prepared software
- an understanding of the basic capabilities, applications and limitations of computers.

Computer programs and software should be selected for the science program on the basis of their effectiveness in developing concepts, skills and attitudes identified in the Program of Studies, and may enhance the learning process by providing:

- drill and practice
- simulations
- tutorials
- experience in problem solving/decision making.

USING MEDIA

As with any resource, media materials should be selected with due consideration for the goals of the program and needs of the learner. Media materials that might be used to supplement instruction include:

- newspapers and periodicals
- television and video recordings
- films and filmstrips.

Media materials must be carefully previewed for accuracy, validity and level of maturity. Only those materials relevant to student experience and need should be selected for use. The following questions might be considered when selecting media resources for the science classroom.

- Does the resource support the major goals and learning objectives of the science program?
- Does the resource meet individual needs and learning styles?

- Does the resource reinforce, enrich or extend the program?
- Is the content relevant, accurate and current?
- How appropriate is the timing and delivery?
- Does the media demonstrate abstract ideas?
- How well does the media fit into existing curricula and teaching/learning needs?
- What kind of preparation is required?
- How might learning be evaluated?
- What forms of follow-up activities will be required?

A listing of media materials that support specific learning objectives within the science program is provided in the *Teacher Resource Manual*. The guidelines provided below will assist teachers in planning instructional activities that involve the use of these and other media resources considered appropriate for use within the science classroom.

- The resource need not be shown in its entirety. Selected portions may more effectively meet student needs.

- Consider viewing audio-visual resources without audio accompaniment, or with only teacher accompaniment.

- Provide students with a prepared question sheet for use while the media is being viewed. This will focus attention on relevant aspects of the topic/issue being investigated.

- Media materials may be viewed more than once. They might be initially viewed in an uninterrupted manner, and then a second time for note-taking or answering questions.

- Plan specific follow-up activities to ensure that students have understood key concepts and ideas related to the investigation.

EVALUATION

Evaluation should be an ongoing part of the teaching and learning process, providing feedback to the student, the teacher, and the parent. Major functions served by the process of evaluation include:

- provision of feedback to the student relative to success in the learning process. Students often have difficulty in monitoring and regulating their learning behaviours, and require a great deal of external feedback as to their progress. Feedback and encouragement must be provided on a regular basis
- provision of information to the teacher concerning the appropriateness of learning goals and objectives, and the effectiveness of learning strategies and materials used. Such information enables the teacher to modify the program as required with respect to pacing, learning resources, teaching methods or objectives
- provision of information to the parent regarding the student's progress. Where possible, reports to parents should be interpreted through an interview or letter so that the implications of the evaluation are understood.

Evaluation should serve diagnostic purposes in identifying student strengths and weaknesses, as well as summative needs in measuring overall growth. Because evaluation is an integral part of all aspects of the instructional process, information used in the evaluation of a student should be gathered from a variety of sources by using a variety of methods. The evaluation process in science must consist of more than paper-and-pencil tests. While such tests may be an effective way of evaluating some learning outcomes, the evaluation program should include, to some degree, the use of all of the following sources of information:

- both formal and informal observation of student attitudes and performance
- oral and written presentations describing the outcomes of investigation
- personal interviews with students
- project work
- feedback from parents
- teacher rating scales/checklists/anecdotal records
- self-rating/self-marking
- peer marking
- written achievement tests on specific learning objectives or on topics investigated
- practical tests on laboratory procedures
- records of previous achievement
- suitable standardized exams.

STRATEGIES FOR EFFECTIVE EVALUATION

Evaluation may, in the past, have been the process by which some students within the program were identified as "failures". These students will go to extreme measures to avoid being "tested" again. Absence from exams, feigning an "I don't care" attitude, or not giving their best effort so that anticipated failure can be explained with "I didn't try", are all common behaviours. A variety of assessment procedures should be used so as to draw upon students' strengths and provide for their success in the evaluation process.

The strategies that follow are intended to serve as guidelines to the teacher in developing a system of evaluation that will improve both student learning and the quality of the science program offered to students.

- Provide frequent opportunities for students to "demonstrate" their understanding of concepts and skills through discussion, project work and group activities.

- "Observation" of the student in small group situations often provides insights as to the student's:

  - level of independence with the work
  - ability to use the strategies of inquiry/problem solving/decision making
  - understanding and ability to apply concepts and skills to new situations.

- Evaluation should emphasize the "synthesis" of a variety of knowledge and process objectives rather than recall or recognition of isolated facts. Provide students with informal situations in which they can demonstrate their application of knowledge, skills and problem-solving strategies in simple investigations.

- Personal interviews can be structured to provide feedback to both student and teacher relative to various aspects of the science program. In addition to providing feedback and encouragement to the student, such interviews may also provide direction to the teacher in the selection/modification of teaching strategies.

- Overdependence on paper-and-pencil techniques for evaluation often does not permit the student with learning difficulties to do well. When planning formal evaluation procedures, caution should be exercised with regard to the overuse of:

  - multiple choice exams
  - difficult wording and vocabulary
  - simple recall of information without understanding and application.

- Provision of taped versions of tests for students who experience difficulty with reading is often a useful strategy. Some students may also benefit if allowed to explain answers on tape, or to another trustworthy individual.

- Provide encouragement by asking questions and making statements that will prompt students to evaluate their own work and learning. Some examples might include:

  - "You did a good job of _(be specific)____."
  - "What steps did you find most difficult?"
  - "What made it difficult?"
  - "How could you improve your work in this question?"

  Such techniques will encourage students to be less "reward dependent" and more responsible for their own learning.

- Provide opportunities for the use of self and peer evaluation techniques.

- When planning formal evaluation, students should be given plenty of advance notice and a study guide to highlight the areas that need to be reviewed. Students rarely do their best when caught off guard by a "surprise quiz".

- Students often do not do their best under time pressure. Provide plenty of time for students to complete their work.

The *Teacher Resource Manual* contains additional guides and checklists for evaluating student performance and achievement in the science program.

SCOPE AND SEQUENCE

The scope and sequence chart provided on the following pages outlines the concepts, skills and attitudes that are addressed throughout Science 16 and 26. As students differ in the rate at which they acquire competencies in science, the chart is intended to assist teachers in assessing present levels of student performance, and in diagnosing individual strengths and weaknesses.

In using the scope and sequence, it should be noted that:

- **attitudes and skills are developmental through Science 16 and 26** (i.e., the spiral approach). Students will refine and extend the attitudes and skills developed in Science 16 through more extensive applications in Science 26.

- **concepts developed in the Science 16 program are in most cases discrete from concepts developed in the Science 26 program.** Effort has been made to apportion concepts throughout Science 16 and Science 26 on the basis of their cognitive demand.

- **the attitudes, skills and concepts are interdependent at each grade level, and are not meant to be developed in isolation.** Although some concepts and skills may be mastered more effectively through discrete instruction, this approach is not advocated as a primary focus of instruction. The thematic structure permits a holistic view of instruction through the linking of strategies and skills.

- most students will continue to use concrete operational thinking, depending upon personal and tangible experience in order to link ideas. **Instruction should generally begin with an operational understanding of ideas at the Science 16 level, and encourage students to extend their thinking to more abstract levels that are cognitively appropriate at the Science 26 level.** (The *Teacher Resource Manuals* for Science 16 and 26 provide for the development of thinking skills through themes that reflect increasing levels of analysis and critical thought.)

Teachers are encouraged to examine the Scope and Sequence chart for the I.O.P. junior high school science program (Grades 8 and 9). An understanding of the developmental progression of concepts, process and skill occurring in Grade 8 and Grade 9 will facilitate articulation between the junior high and senior high science programs.

Although the Scope and Sequence chart provides a useful overview of the Science 16 and Science 26 programs, teachers are encouraged to use the "Program of Studies/Presentation of Content" section of this document in planning and sequencing instructional activities.

LIFE FORMS AND CHANGES

<table>
<tr><th></th><th>SCIENCE 16
SYSTEMS OF THE HUMAN BODY</th><th>SCIENCE 26
PERSONAL HEALTH AND LIFESTYLE</th></tr>
<tr><td>ATTITUDES</td><td colspan="2">Students will be encouraged to:
• display a positive attitude toward the learning of concepts and skills in science
• appreciate the intricate workings and balance within the human body
• appreciate the contributions of science and technology to human health
• value knowledge gained for its usefulness on a personal level
• appreciate the need for informed decision making at both personal and societal levels
• appreciate that ethical dilemmas may arise from the application of scientific research and/or medical technologies
• display responsible attitudes toward personal health through nutrition, exercise, safety and lifestyle.</td></tr>
<tr><td>SKILLS</td><td colspan="2">Students will be expected to demonstrate an ability to:
• collect data related to critical life functions and body systems through observation, interview and/or research
• design an experiment, through class discussion, that illustrates the use of a technology in monitoring variations in the functioning of a body system
• use selected monitoring technologies in collecting data about personal health and fitness factors
• analyze and assess personal health and fitness factors by identifying relationships, by considering consequences, and by examining a variety of viewpoints
• infer potential threats to personal health that may be caused by lifestyle factors
• apply the results of investigation to personal situation, identifying appropriate strategies for monitoring and maintaining personal health.</td></tr>
<tr><td>CONCEPTS</td><td>Students will be expected to demonstrate an understanding that:
• the human body is a product of a number of body systems working together to perform critical life functions
• each body system has specific structures that enable it to perform a critical life function
• functional relationships among systems of the human body are critical to life
• medical technology can be used to monitor body conditions and personal health factors
• interrelationships exist between nutrition, level of fitness and personal health
• societal issues may arise from the use of technologies in preserving balance among systems of the human body.</td><td>Students will be expected to demonstrate an understanding that:
• personal diet should include minimal amounts of certain foods in order to maintain health
• much of our food, particularly processed food items, contain additives
• drugs, alcohol and tobacco may affect nutritional requirements and cause related disease
• a relationship exists between caloric intake, energy output and body weight
• physical exercise will assist in maintaining cardiovascular and respiratory health
• emotional factors can have both positive and negative effects on personal health and well-being
• interrelationships exist among a variety of lifestyle factors (e.g., diet, exercise, substance use/abuse, stress) and personal health.</td></tr>
</table>

USING MATERIALS AND PRODUCTS

	SCIENCE 16 CHEMISTRY FOR THE CONSUMER	SCIENCE 26 MATERIALS WE USE
ATTITUDES	Students will be encouraged to: • display a positive attitude toward the learning of concepts and skills in science • value scientific principles and processes for their usefulness in providing explanations of everyday phenomena • appreciate the usefulness of measurement skills in real life and work-related situations • appreciate the role of technology in solving practical problems • appreciate the usefulness and potential hazards of common household materials • display a respect for personal safety and the safety of others when handling potentially hazardous materials • appreciate the contributions of science and technology to the development of a variety of materials and products that we depend upon and use each day.	
SKILLS	Students will be expected to demonstrate an ability to: • conduct experiments that illustrate the properties of familiar substances and materials • design experiments, through class discussion, that illustrate predictability in the behaviour of substances and materials that are investigated • effectively use apparatus and equipment when conducting experiments • make qualitative and quantitative observations when conducting experiments • identify patterns and relationships in the behaviour of substances and materials, and use this information to explain the application of particular consumer products in everyday situations • predict heat exchange in practical situations, and use appropriate procedures for protecting living organisms and other materials from excessive heat transfer • accurately read product labels and consumer reports in order to determine the composition and intended use of familiar household products • apply appropriate techniques for identifying acids, bases and other hazardous substances • use safe procedures for handling and storing potentially dangerous substances.	
CONCEPTS	Students will be expected to demonstrate an understanding that: • the properties of household solutions are different than those of pure substances • permanent suspensions have useful properties and a variety of applications in the home • acids and bases have useful properties and a variety of applications in the home • solubility varies with temperature • many chemical reactions may require or emit energy in the form of heat • heat flows from areas of high temperature to areas of lower temperature • handling, storing and using potentially hazardous chemical products requires knowledge and care.	Students will be expected to demonstrate an understanding that: • the properties of the materials and products we use are determined by their composition • models and other conceptual inventions are useful in explaining the composition and behaviour of matter • materials and products are derived from both natural and synthetic materials • the properties of materials determine their suitability for particular applications • our use of natural and synthetic materials affects both environment and resources • the process of biodegradation reduces the impact that some products have on the environment • science and technology assist in solving practical problems and responding to environmental issues by developing new materials.

TECHNOLOGY AT WORK

<table>
<tr><th></th><th>SCIENCE 16
USING SYSTEMS AND TECHNOLOGIES</th><th>SCIENCE 26
TECHNOLOGY IN TRANSPORTATION</th></tr>
<tr><td>ATTITUDES</td><td colspan="2">Students will be encouraged to:
• display a positive attitude toward the learning of concepts and skills in science
• appreciate the roles of science and technology in serving human needs, and the usefulness of technological problem-solving skills in finding solutions to practical problems
• develop confidence in personal ability to understand and solve practical problems through the use of science and technology
• display a concern for safety when using technological products and processes
• appreciate that ethical dilemmas may arise from the application of scientific research and/or technological developments
• appreciate the relationships among science, technology and society.</td></tr>
<tr><td>SKILLS</td><td colspan="2">Students will be expected to demonstrate an ability to:
• observe and analyze the operation of familiar devices and systems, identifying component parts and scientific principles that are utilized
• prepare systems diagrams that illustrate how component parts and/or subsystems within a technological device work together in accomplishing a task
• test and evaluate the performance of a familiar device by
– identifying basic principles governing its operation and use
– inferring potential malfunctions and appropriate maintenance/repair procedures
– suggesting ways to improve efficiency of design and/or operation
• design and construct a simple technological device or process by
– identifying a relevant need or problem not satisfied by technology
– identifying alternative approaches/designs to deal with the problem
– selecting a design and constructing the device
– testing and troubleshooting the device
• infer how specific technologies have personal application and solve practical problems.</td></tr>
<tr><td>CONCEPTS</td><td>Students will be expected to demonstrate an understanding that:
• technology is the process of using scientific knowledge to solve practical problems
• basic scientific principles are associated with the functioning of technological devices
• many technological systems consist of combinations of sub-systems that work together in accomplishing a particular task
• science can be used to advance technology and technology can be used to advance science
• new and emerging technological products/processes reflect current needs and wants in society
• products of technology are often used by society before the full extent of benefits/problems resulting from their use can be known.</td><td>Students will be expected to demonstrate an understanding that:
• the automobile is a technological system consisting of a number of subsystems that work together
• basic scientific principles are associated with the functioning of sub-systems in an automobile
• simple maintenance procedures contribute to the efficient performance and general safety of an automobile
• the nature of injuries sustained in an automobile accident can be anticipated by considering the effects of first and second collisions
• technology has contributed to safe travel through the development of highway/automobile safety features
• political, ethical and economic perspectives often interact with science and technology in making decisions that advance safe travel.</td></tr>
</table>

UNDERSTANDING OUR ENVIRONMENT

<table>
<tr><th></th><th>SCIENCE 16
MANAGING ENVIRONMENT AND RESOURCES</th><th>SCIENCE 26
ENERGY AND THE ENVIRONMENT</th></tr>
<tr><td>ATTITUDES</td><td colspan="2">Students will be encouraged to:
• display a positive attitude toward the learning of concepts and skills in science
• appreciate the fragility of the biosphere
• appreciate the interdependence of self with other living forms and the environment
• appreciate that environmental issues involve significant relationships among science, technology and society
• realize our inability to anticipate the environmental effects of human activities
• appreciate that the collective action of individuals can have significant impact
• develop a sense of personal responsibility in relation to environmental issues.</td></tr>
<tr><td>SKILLS</td><td colspan="2">Students will be expected to demonstrate an ability to:
• identify an environmental issue related to the local use of natural resources
• gather information related to the issue through observation, interview and/or research
• design experiments, through class discussion, that illustrate how particular practices or products are related to the issue and influence environmental quality
• analyze and assess information by identifying patterns and relationships, by judging the reliability/validity of information gathered and by considering consequences
• communicate the results of investigation verbally, through the use of models and diagrams, and/or through written expression
• take an informed position on the issue, identifying strategies that may be used to deal with the situation.</td></tr>
<tr><td>CONCEPTS</td><td>Students will be expected to demonstrate an understanding that:
• the biosphere is a thin layer on the surface of the earth, able to support life
• a continuous supply of solar energy is essential to life
• life depends upon recycling processes
• living organisms interact with each other and with the physical environment
• individuals and society influence the quality of the environment
• developments in science and technology may have unforeseen consequences on society and the environment
• individuals and society can become involved in the resolution of ecological problems that arise.</td><td>Students will be expected to demonstrate an understanding that:
• a variety of different forms of energy are used at home and at work
• there are renewable and non-renewable sources of energy
• energy systems have input, conversion and output components
• the total energy of a system is conserved
• energy efficiency ratings describe the portion of input energy that is converted to useful energy
• personal energy consumption can be analyzed and monitored
• energy conservation involves the interaction of economic, political and ethical perspectives with science and technology.</td></tr>
</table>

PROGRAM OF STUDIES/PRESENTATION OF CONTENT

The "Program of Studies/Presentation of Content" describes the required concepts, skills and attitudes identified for Science 16. Learning objectives have been clustered into four themes that can be used to deliver the program, and include:

- Systems of the Human Body
- Chemistry for the Consumer
- Using Systems and Technologies
- Managing Environment and Resources.

The shaded statements contained in the Program of Studies (Column One) enable the reader to readily identify those portions of the program that are prescribed.

The advice and direction offered throughout Columns Two, Three and Four is not prescriptive, and is offered only as a service to teachers. Column Two, Related Life Skills, establishes an immediate need or use for each concept/skill being studied and suggests ways of planning relevant learning experiences. Further suggestions for relating science competencies to applications in occupational courses and other academic disciplines are provided in Column Three, Related Applications Across the Curriculum. The references provided in this column will facilitate curricular integration by establishing a base for cooperative planning among other subject areas/teachers in the program. A variety of strategies useful in addressing developmental characteristics and learning styles of the student are provided in Column Four, Suggested Strategies/Activities. Teachers are encouraged to use the advice and direction offered throughout Columns Two, Three and Four in conjunction with suggestions provided in the *Teacher Resource Manual* when planning thematic units of instruction that address learning objectives identified in the Program of Studies.

SCIENCE 16

SYSTEMS OF THE HUMAN BODY

OVERVIEW:

Life functions are performed by a number of body systems interacting with one another and the environment. An understanding of these body systems and various factors that may affect their functioning will assist individuals in acquiring and maintaining healthy lifestyles. This theme will provide opportunities for students to:

- examine critical life functions and the body systems that perform these functions
- recognize interrelationships that exist among nutrition, level of fitness and personal health factors
- identify appropriate strategies for acquiring and maintaining personal health.

ATTITUDES:

Students will be encouraged to:

- display a positive attitude toward the learning of concepts and skills in science by
  - showing interest and curiosity through willingness to ask questions, share observations and ideas, and seek answers
  - performing investigations and completing assignments independently and in cooperation with others

- appreciate the intricate workings and balance within the human body

- appreciate the contributions of science and technology to human health

- value knowledge gained for its usefulness on a personal level

- appreciate the need for informed decision making at both personal and societal levels

- appreciate that ethical dilemmas may arise from the application of scientific research and/or medical technologies

- display responsible attitudes toward personal health through nutrition, exercise, safety and lifestyle.

LEARNING OBJECTIVES

SKILLS:

DEMONSTRATES ABILITY TO USE THE SKILLS AND PROCESSES OF SCIENCE TO MONITOR AND EVALUATE PERSONAL HEALTH FACTORS RELATED TO CRITICAL LIFE FUNCTIONS.

- Collects data related to critical life functions and body systems through observation, interview and/or research.
- Designs an experiment, through class discussion, that illustrates the use of a technology (e.g., stethoscope) in monitoring variations in the functioning of a body system.
- Uses selected monitoring technologies in collecting data about personal health and fitness factors.
- Analyzes and assesses personal health and fitness factors by identifying relationships, by considering consequences, and by examining a variety of viewpoints.
- Infers potential threats to personal health that may be caused by lifestyle factors (e.g., diet, level of activity).
- Applies the results of investigation to personal situation, identifying appropriate strategies for monitoring and maintaining personal health.

CONCEPTS:

DEMONSTRATES AN UNDERSTANDING THAT THE HUMAN BODY IS THE PRODUCT OF A NUMBER OF BODY SYSTEMS WORKING TOGETHER TO PERFORM CRITICAL LIFE FUNCTIONS.

- Identifies critical life functions and the body systems that perform them.
- Describes how each system contributes to the health of the individual.

DEMONSTRATES AN UNDERSTANDING OF THE DIGESTIVE SYSTEM AND CIRCULATORY SYSTEM IN THE HUMAN BODY.

- Identifies individual structures within each system.
- Describes the functions associated with each structure.

Related Life Skills

Identifies lifestyle factors that may affect balance among systems of the human body:

- eating habits
- work activities
- leisure activities.

Recognizes strategies that can be used in monitoring personal health. Evaluates personal health factors in relation to:

- blood pressure
- pulse rate
- body mass index
- lung capacity
- endurance
- strength
- flexibility
- diet.

Recognizes how various technological devices may assist in monitoring critical life functions:

- microscope
- stethoscope
- endoscope
- blood-pressure gauge
- x-rays/scanners
- electrocardiogram.

Considers a variety of factors in planning a healthy diet:

- lifestyle
- nutritional requirements
- calorie requirements
- food preferences
- financial resources.

Practises weight management through:

- appropriate diet
- regular exercise.

Recognizes the benefits of incorporating physical fitness into one's lifestyle:

- increased endurance/strength/flexibility
- prevention of injuries
- reduction of neuromuscular tension.

Related Applications Across the Curriculum

English

Uses skills of "comprehension" in gathering and evaluating information related to personal health and lifestyle:

- identifies key concepts
- discards irrelevant information
- identifies cause and effect relationships
- makes inferences and predictions
- draws conclusions
- summarizes.

Uses skills of "following directions" when performing investigations:

- discerns when instructions must be followed exactly
- interprets verbal instructions
- interprets written text that provides directions
- interprets tables in order to follow directions.

Uses skills learned in "discussing" when evaluating and applying the results of investigation:

- distinguishes between fact/fiction/opinion
- recognizes that an issue can have two sides
- expresses personal opinion
- permits/respects opinions of others.

Mathematics

Uses appropriate units/tools/procedures when measuring:

- distance
- capacity
- time.

Uses skills involving measurement, number operations and ratio/proportion when monitoring personal health factors:

- height/weight
- caloric requirements
- heart rate
- fitness level.

Uses skills of "data interpretation and display" when gathering/interpreting health statistics:

- reads/interprets information provided in tables/charts/graphs
- interprets measures of central tendency.

Suggested Strategies/Activities

Select activities that will encourage students to develop a personal strategy for acquiring and maintaining a healthy body. Provide opportunities for students to:

- examine their own practices as they relate to nutrition and exercise
- monitor the effects of these practices on the functioning of major body systems
- evaluate daily choices/decisions that are made in areas that affect personal health.

Organize classroom activities in ways that encourage students to be active participants in thinking and learning. Instruction should provide opportunity for:

- total group involvement in listening/viewing and interacting
- cooperative group work in pairs or small groups
- individual student work.

The sequence of activities outlined below may be useful in fostering active student involvement throughout thematic investigations.

- Involve students in a situation that stimulates them to ask questions and identify problems.
- Record questions/problems on the blackboard/overhead.
- Encourage students to suggest ideas related to the questions asked.
- Ask students to design a research proposal, describing:
  - questions/problems they will answer
  - how and where they will find their information
  - how long it will take them
  - what equipment they will need.
- Permit students to conduct an inquiry on their problem using their suggested activities. This may include:
  - observation/experiment
  - consulting books
  - interviewing knowledgeable people.
- Provide opportunity for students to report their findings to the class. Encourage students to comment on:
  - whether or not they really found the answer they were looking for
  - possible alternative answers or explanations
  - further investigations that might follow.

LEARNING OBJECTIVES	Related Life Skills

CONCEPTS (continued):

DEMONSTRATES AN UNDERSTANDING OF THE IMPORTANCE OF FUNCTIONAL RELATIONSHIPS AMONG SYSTEMS OF THE HUMAN BODY.

- Illustrates, through example, how a body system adjusts to changes in other body systems in order to maintain balance (e.g., blood sugar, breathing and heart rate).
- Illustrates, through example, what happens when disturbances occur in one body system and other systems are unable to adjust (e.g., stroke, heart attack).

DEMONSTRATES AN UNDERSTANDING OF THE CONTRIBUTIONS OF MEDICAL TECHNOLOGY IN MONITORING BODY CONDITIONS.

- Gives examples of ways in which technology can be used to monitor critical life functions.
- Describes how technology may assist in diagnosing/treating malfunctions within body systems.
- Illustrates, through example, how science and technology work together to expand our knowledge of body systems.

DEMONSTRATES AN UNDERSTANDING OF INTERRELATIONSHIPS THAT EXIST AMONG NUTRITION, LEVEL OF FITNESS, PERSONAL HEALTH AND LIFESTYLE.

- Explains how lifestyle factors and decisions may affect personal health.
- Identifies strategies for maintaining personal health through diet and physical exercise.
- Infers the consequences of improper diet, weight and exercise on personal health.

DEMONSTRATES AN UNDERSTANDING OF ISSUES THAT MAY ARISE FROM THE USE OF TECHNOLOGIES IN PRESERVING BALANCE AMONG SYSTEMS OF THE HUMAN BODY.

- Describes how technologies can be used to preserve the balance of life when one or more systems are in failure (e.g., organ transplants, life-support systems).
- Identifies societal issues that arise when technologies are used to preserve balance when a system is in temporary or permanent failure.

Formulates personal strategies for maintaining/increasing personal fitness level. Strategies might involve:

- exercise routines at school or work
- selection of appropriate recreational/ leisure time activities
- participation in sports/fitness programs.

Recognizes societal factors that may influence an individual's diet and recreational activities:

- fashion/style/trends
- advertising/media
- peer group.

Recognizes symptoms that may indicate malfunctions within systems of the human body:

- anemia
- ulcers
- heart attack
- high blood pressure
- heart burn
- pneumonia
- diabetes.

Identifies preventative measures/remedies for common malfunctions within systems of the human body.

Recognizes recent developments in technology that can be used to preserve balance among systems of the human body:

- organ transplants
- artificial body parts
- dialysis
- colostomies.

Avoids exposure to environmental pollutants that are known to have detrimental effects on health:

- asbestos
- lead and mercury
- formaldehyde insulation.

Related Applications Across the Curriculum

Social Studies

Uses knowledge of community services in gaining access to medical assistance and advice:

- medical facilities
- government counselling agencies.

Uses knowledge and awareness gained from "current affairs" in identifying health problems and threats of current concern.

Recognizes the burden that unhealthy lifestyles place upon our social support services and health care system:

- support services required for people suffering from alcohol-related disorders
- health care for people suffering from diseases caused by the use of tobacco.

Uses a "decision-making model" in identifying personal and societal actions that can be taken in promoting health and fitness.

Recognizes personal and social responsibilities relative to health and lifestyle that are inherent in rights and privileges.

Occupational Courses

Appreciates the effects that personal health and lifestyle have on job selection, acquisition, performance and retention.

Identifies occupational opportunities that exist in areas related to health and fitness. Considers related entrepreneurial opportunities.

Follows "on-the-job" safety and sanitary standards and appreciates their importance in maintaining personal health and the health of co-workers.

Interprets "hazardous product" and "safety" symbols that relate to occupational areas being studied.

Suggested Strategies/Activities

Provide opportunities for students to investigate a variety of recent medical technologies, and to identify:

- their contributions in monitoring and maintaining personal health
- ethical dilemmas that may arise from their application in society.

When examining health issues, guide students through the process of analysis and critical thought by using strategies provided in the *Teacher Resource Manual*: Communication Skills, "Using Critical Thinking Skills".

e.g., – PMI (Plus-Minus-Interesting)
– CAF (Consider All Factors)
– C and S (Consequences and Sequels).

Assist students to develop the required knowledge base by providing a variety of "input" activities (e.g., periodicals, pamphlets, resource people, films, videos). Organize information that is gathered by using strategies suggested in the *Teacher Resource Manual*: Communication Skills (e.g., semantic webs, skeletal outlines, concept circles).

Community Partnerships:

- Invite a nutritionist to discuss the facts, fads and fallacies of eating habits and diets.
- Invite a doctor (or nurse) to discuss the relationship between nutrition, fitness and lifestyle.
- Invite a local fitness expert to discuss:
  - personal fitness measures
  - strategies for improving fitness.
- Obtain health/fitness pamphlets and brochures from a local doctor, the school nurse, or community agency responsible for health.
- Invite the school nurse to demonstrate appropriate techniques for monitoring personal health factors (e.g., blood pressure, pulse rate).
- Invite a first aid specialist to explain basic emergency procedures that should be followed in situations involving accidental injury or ill health.
- Invite a public health worker to discuss immunization practices.
- Invite a pharmacist to discuss:
  - prescription/non-prescription drugs
  - their effects on the body
  - the interpretation of label directions/dosages
  - drug safety in the home.
- Invite a representative of Consumer and Corporate Affairs to discuss Canada's food labelling laws.

SCIENCE 16

CHEMISTRY FOR THE CONSUMER

OVERVIEW:

Learning objectives will focus attention on the chemical properties and active ingredients of substances used by students in their everyday lives. By carrying out a series of controlled experiments, students will investigate the composition of a variety of familiar household products and the scientific principles that underlie their effectiveness. Students will be expected to develop strategies for:

- safely handling of potentially dangerous substances and situations encountered within the home and work environments
- selecting consumer products on the basis of their active ingredients and ability to accomplish a given task.

ATTITUDES:

Students will be encouraged to:

- display a positive attitude toward the learning of concepts and skills in science by
  - showing interest and curiosity through willingness to ask questions, share observations and ideas, and seek answers
  - performing investigations and completing assignments independently and in cooperation with others
- value scientific principles and processes for their usefulness in providing an understanding of common household phenomena
- appreciate the usefulness of measurement skills in real life and work-related situations
- appreciate the role of technology in solving practical problems
- appreciate both the usefulness and potential hazards of common household substances
- display a respect for personal safety and the safety of others when handling potentially hazardous substances
- appreciate the contributions of science and technology to the development of a variety of materials and products that we depend upon and use each day.

LEARNING OBJECTIVES

SKILLS:

DEMONSTRATES ABILITY TO USE THE SKILLS AND PROCESSES OF SCIENCE TO INVESTIGATE THE PROPERTIES AND REACTIONS OF FAMILIAR HOUSEHOLD SUBSTANCES.

- Conducts experiments that illustrate the properties of pure substances and solutions.
- Designs experiments, through class discussion, that illustrate:
  - factors affecting solubility
  - the differences between temporary and permanent suspensions
  - the behaviour of acid and base substances.
- Effectively uses apparatus and equipment when conducting experiments.
- Makes qualitative and quantitative observations when conducting experiments.
- Identifies patterns and relationships in the behaviour of substances and solutions investigated, and applies this information by explaining how selected chemical products and reactions are used in performing routine tasks (e.g., cooking, cleaning).
- Predicts heat exchange in practical situations, and uses appropriate procedures for protecting living organisms and other materials from excessive heat transfer.
- Accurately reads product labels and consumer reports in order to determine the composition and intended use of familiar household products.
- Applies appropriate techniques for identifying acids, bases and other chemical substances.
- Uses safe procedures for handling and storing potentially dangerous substances.

CONCEPTS:

DEMONSTRATES AN UNDERSTANDING THAT THE PROPERTIES OF HOUSEHOLD SOLUTIONS ARE DIFFERENT THAN THOSE OF PURE SUBSTANCES.

- Describes the properties of solutions and the properties of pure substances.
- Distinguishes between familiar household substances that are pure and those that are solutions, giving examples of each.

DEMONSTRATES AN UNDERSTANDING OF THE PROPERTIES OF PERMANENT SUSPENSIONS (E.G., FOAMS, EMULSIONS) USED IN THE HOME.

- Describes the properties of permanent suspensions.
- Identifies examples of familiar permanent suspensions used in the home.
- Explains the importance of permanent suspensions by relating the consequences of separation to common household products and situations.

Related Life Skills

Applies knowledge of chemical substances and reactions in performing routine activities:

- cooking and baking
- cleaning and laundry
- maintaining personal hygiene
- painting.

Recognizes and uses techniques that increase/hasten solubility in practical situations:

- dissolving food substances in crystal form
- cleaning and removing stains.

Applies knowledge of the effect of the concentration of a solution on its freezing and boiling points when:

- using antifreeze
- raising cooking temperatures
- controlling ice deposits on sidewalks/roads.

Recognizes familiar uses of acids and bases in cooking and baking, performing household cleaning tasks, and maintaining personal health and hygiene:

- use of leavening agents
- control of odours
- household cleaning and stain removal
- use of oven and drain cleaners
- care of hair and teeth
- digestion of food.

Applies techniques for identifying acid and base substances in practical situations:

- acids taste sour, bases taste bitter
- acids wear away metals and cause colour changes
- bases feel slippery/soapy and dissolve fats and oils
- bases destroy the properties of an acid.

Identifies familiar acids found within the home (e.g., citric acid, boric acid, milk, vinegar, aspirin, battery acid).

Identifies familiar bases found within the home (e.g., milk of magnesia, lye, ammonia, baking soda, fertilizer).

Related Applications Across the Curriculum

English

Recognizes the transferability of inquiry strategies developed in English to scientific investigations. Uses these strategies when investigating the properties of familiar household substances:

- identifies cause and effect
- distinguishes between fact/fiction/opinion
- draws conclusions/makes inferences
- makes predictions
- summarizes.

Uses skills of "giving and following directions" when planning and performing experiments:

- recognizes need for sequence
- discerns when instructions must be followed exactly
- interprets verbal and written instructions
- interprets tables, diagrams, signs and symbols in order to follow directions.

Uses skills of "asking and answering" when identifying problems and formulating questions for investigation:

- probes for further information
- formulates increasingly higher levels of questions.

Mathematics

Uses appropriate units/tools/procedures for estimating and measuring:

- mass
- capacity
- time
- temperature.

Applies ratio and proportion skills when:

- describing the composition of chemical mixtures and solutions
- determining appropriate ingredients for mixtures and solutions.

Uses skills of "data interpretation and display" when collecting, organizing, analyzing and communicating data obtained through experimentation:

- collects and organizes data using tally sheets and frequency tables
- displays data in the form of tables/charts and bar/line/picture/circle graphs
- determines appropriate measures of central tendency (e.g., mean, median, mode, range).

Suggested Strategies/Activities

Emphasize active inquiry and involvement in the learning process by encouraging students to:

- observe, think about and discuss the chemical products and reactions they use in real life activities each day
- observe and attempt to explain unusual properties/discrepant events where the substances they use behave in unexpected ways
- engage in dialogue and debate so they may become aware of other explanations and ways of thinking about the phenomena observed.

Assist students to prepare for what they will learn, and to organize and integrate new concepts/relationships by using advance organizers and conceptual overviews that are provided in the *Teacher Resource Manual*: Communication Skills.

e.g.,
- semantic webs
- skeletal outlines
- concept circles.

Model the use of strategies and skills appropriate to conducting experiments by "talking through" an investigation. Illustrate how discrete skills are used at various times throughout the experiment. Ask probing questions that will focus attention on elements of the situation that might be otherwise overlooked. By making students aware of appropriate thought processes, they will be better able to:

- relate specific skills used in an experiment to an overall strategy
- discuss the process they use with their peers and the teacher
- monitor and evaluate their own progress through an investigation.

Additional suggestions for developing inquiry skills are provided in the *Teacher Resource Manual*: The Nature of Science.

Devise experiments that demonstrate the chemical substances and reactions that are used in performing real life tasks (e.g., cleaning/laundering, cooking/baking, personal hygiene). Assist students to develop a strategy for selecting consumer products on the basis of their:

- active ingredients and ability to accomplish a given task
- effect on personal health and the environment.

LEARNING OBJECTIVES

CONCEPTS (continued):

DEMONSTRATES AN UNDERSTANDING OF THE PROPERTIES OF ACID AND BASE SUBSTANCES USED IN THE HOME.

- Describes how acids and bases can be identified according to their natural properties.
- Identifies examples of familiar acids and bases used in the home.
- Illustrates how acids and bases can react with other household substances in both useful and potentially dangerous ways.

DEMONSTRATES AN UNDERSTANDING THAT SOLUBILITY VARIES WITH TEMPERATURE.

- Demonstrates how temperature change affects the solubility of one familiar household solute.
- Cites real life situations in which temperature change affects solubility.
- Explains the concept of unsaturated, saturated and supersaturated solutions.

DEMONSTRATES AN UNDERSTANDING THAT MANY CHEMICAL REACTIONS MAY REQUIRE OR EMIT ENERGY IN THE FORM OF HEAT.

- Distinguishes between types of household reactions that require heat energy and those that produce heat energy.
- Explains the usefulness of household reactions that require and produce heat energy.

DEMONSTRATES AN UNDERSTANDING THAT HEAT FLOWS FROM AREAS OF HIGH TEMPERATURE TO AREAS OF LOWER TEMPERATURE.

- Compares heat exchange by conduction, convection and radiation in different mediums.
- Determines the mode of heat transfer involved in familiar processes used at home and at work.

DEMONSTRATES AN UNDERSTANDING OF SAFE PROCEDURES FOR HANDLING, STORING AND USING POTENTIALLY HARMFUL CHEMICAL PRODUCTS USED IN THE HOME AND AT WORK.

- Identifies common substances that have safety labelling.
- Explains why it is important to read instructions for safe handling.
- Cites the potential dangers of mixing certain household products.
- Describes recovery techniques for common errors in handling.

Related Life Skills

Recognizes the active ingredients and basic scientific principles that underlie the effectiveness of familiar personal care products:

- toothpaste/soap
- deodorant/antiperspirant
- shampoo/hair rinse
- aspirin/milk of magnesia/antacids.

Follows appropriate procedures when using chemical products:

- identifies hazardous chemical symbols
- reads product ingredient labels
- follows directions for use
- recognizes antidotes/recovery techniques for errors in handling
- follows safe storage practices.

Recognizes the potential danger of mixing certain household products:

- bleach and drain cleaners
- ammonia and bleach
- ammonia and aluminum.

Identifies mixtures and solutions of chemical products found in the environment that are often the cause of pollution:

- contamination around water
- acid rain
- dust/smog.

Reads and interprets products ingredient labels in order to distinguish between active/useful ingredients and those which simply add appeal to a product. Uses this information in making informed decisions about product purchase.

Applies knowledge of heat transfer (e.g., conduction, convection and radiation) in understanding familiar processes and technologies:

- construction of cookware/thermos
- methods of cooking (e.g., convection oven, microwave oven)
- home insulation techniques
- methods of heating the home (e.g., central heating system, fireplace)
- construction of downfilled and polyfilled garments.

Social Studies

Identifies businesses/industries within the local community that utilize chemical products.

Recognizes current health and safety concerns related to the use of chemical substances in the local community:

- personal health and safety in relation to the use of particular personal care/household products
- the effects of various forms of chemical pollution on personal health and the environment.

Uses problem-solving and decision-making skills in developing strategies for dealing with local/global issues arising from the disposal of non-biodegradable chemical substances.

Investigates local bylaws that control the transporting/storage/disposal of potentially hazardous chemical substances.

Occupational Courses

Applies knowledge of personal care and household products in:

- maintaining personal hygiene
- sanitizing tools, equipment and the work area
- lubricating moving parts of tools and equipment.

Follows safe handling and storage practices when using potentially hazardous materials in the workplace:

- reads/interprets safety symbols and directions provided on product labels
- understands and uses the Workplace Hazardous Materials Information System (WHMIS).

Recognizes that chemical substances/reactions are used in a variety of occupations when preparing a product and/or providing a service. (Teachers are encouraged to identify the chemical products/processes used by students in their occupational courses, and to plan investigations that explore the scientific principles that underlie their effectiveness.)

Activities in this theme provide much opportunity for enhancing interpersonal skills among students within the classroom. Experiments can be performed in group settings through the use of group problem solving. As interactive/communicative problems become evident, use a problem-solving approach to generate:

- reasons for the difficulty
- strategies to avoid the problem next time.

A framework for social problem solving is provided in the *Teacher Resource Manual*: Interpersonal Skills and Cooperative Learning.

Encourage students to develop appropriate safety attitudes and procedures by:

- viewing slide sets/videos/cartoons that demonstrate safe laboratory procedures
- interpreting directions/warning labels that accompany potentially dangerous substances
- discussing the recovery techniques for errors in handling potentially dangerous substances.

Community Partnerships:

- Invite a paramedic/fire chief to discuss:
  - safe handling/storage techniques for potentially dangerous products found in the home
  - recovery techniques for errors in handling hazardous substances.
- Invite a local pharmacist to discuss the chemical properties/active ingredients of mixtures and solutions used in personal care products.
- Invite a representative from the hair care, dry cleaning or automotives industry to discuss the chemical properties/active ingredients of mixtures and solutions used in their respective service areas.
- Visit local industry and observe the use of chemical products/processes and the safety precautions taken by workers.
- Invite a local agriculturalist/soil expert to discuss the effects of soil acidity on plant growth, and methods of adjusting acid level in soil.
- Visit local stores and gather information about familiar consumer products by reading product labels (e.g., product composition, active ingredients, directions for use, recovery techniques for errors in handling).

SCIENCE 16

USING SYSTEMS AND TECHNOLOGIES

OVERVIEW:

Many tasks performed at home and in the workplace rely upon the use of technological devices and systems. An understanding of familiar technologies, as well as the process by which they are developed, will assist students to use technology effectively in practical situations. This theme will enable students to:

- develop an understanding of scientific principles governing the operation of familiar technologies
- examine, test and evaluate simple devices and systems that are used at home and in the workplace
- design and construct a simple device that is intended to meet a specific need.

ATTITUDES:

Students will be encouraged to:

- display a positive attitude toward the learning of concepts and skills in science by
  - showing interest and curiosity through willingness to ask questions, share observations and ideas, and seek answers
  - performing investigations and completing assignments independently and in cooperation with others

- appreciate the roles of science and technology in serving human needs, and the usefulness of technological problem-solving skills in finding solutions to practical problems

- develop confidence in personal ability to understand and solve practical problems through the use of science and technology

- display a concern for safety when using technological devices and systems

- appreciate that ethical dilemmas may arise from the application of scientific research and/or technological developments

- appreciate the relationships among science, technology and society.

LEARNING OBJECTIVES

SKILLS:

DEMONSTRATES ABILITY TO USE THE SKILLS OF SCIENCE AND A PROBLEM-SOLVING STRATEGY TO SOLVE PRACTICAL PROBLEMS OF A TECHNOLOGICAL NATURE.

- Identifies specific relationships that exist between science and current technologies.
- Observes and analyzes the operation of familiar devices and systems, identifying component parts and scientific principles that are utilized.
- Prepares systems diagrams that illustrate how component parts and/or subsystems within a technological device work together in accomplishing a task.
- Tests and evaluates the performance of a familiar device:
  - identifies basic principles governing its operation and use
  - infers potential malfunctions and appropriate maintenance/repair procedures
  - suggests ways to improve efficiency of design and/or operation.
- Uses a problem-solving strategy to design and construct a simple technological device or process:
  - identifies a current need or problem not satisfied by technology
  - identifies alternative approaches/designs to deal with the problem
  - selects a design and constructs the device
  - tests and troubleshoots the device
  - evaluates the product and the process.
- Infers how specific technologies have personal application and solve practical problems.

CONCEPTS:

DEMONSTRATES AN UNDERSTANDING OF TECHNOLOGY AS THE PROCESS OF USING SCIENTIFIC KNOWLEDGE TO SOLVE PRACTICAL PROBLEMS AND SATISFY HUMAN NEEDS/WANTS.

- Identifies a variety of human needs/wants and the technological products and/or processes developed to meet them.
- Illustrates, with at least one example, the application of scientific knowledge in solving a practical problem.

Related Life Skills

Appreciates the contributions of science and technology in:

- the design/operation of familiar labour saving devices
- developing new products/processes that solve practical problems and satisfy human needs.

Recognizes the effects of technology on:

- activities at home and in the workplace
- leisure time activities
- personal health and lifestyle
- living and non-living factors in the environment.

Develops a strategy for troubleshooting and repairing simple devices and systems used in the home:

- identifies the source of the problem
- considers alternative approaches to a solution
- evaluates alternatives and makes necessary repairs.

Recognizes the application of simple machines in familiar tools, devices and systems designed for specific purposes:

- shovel/broom
- hammer/pliers/screwdriver
- doorknob/can opener
- ramp/stairs
- bicycle/motorcycle/automobile
- moving toys
- lawn mower/sewing machine.

Recognizes how basic principles related to electromagnetics contribute to the functioning of familiar technologies:

- electric motors
- automatic door openers
- buzzers and chimes
- transformers
- induction coils
- tape recorders
- telephone.

Related Applications Across the Curriculum

English

Uses skills of "comprehension" when gathering and interpreting information related to the operation of familiar technologies:

- develops technical vocabulary
- identifies cause and effect relationships
- observes sequence of events
- draws conclusions/makes inferences
- makes predictions
- uses visual/graphic information.

Uses skills of "giving and following directions" when planning and performing investigations:

- recognizes need for sequence
- interprets verbal and written instructions
- interprets tables, diagrams, signs and symbols in order to follow instructions.

Uses skills of "reporting/making notes" when communicating the results of investigation:

- selects relevant details
- outlines
- reports
- uses symbols and abbreviations.

Debates current issues related to the effects of technology on:

- personal health and lifestyle factors
- environmental quality.

Mathematics

Measures distance, mass, force, volume, time and temperature while investigating selected technologies.

Uses ratio skills in developing an understanding of the concepts of:

- pressure
- mechanical advantage
- efficiency.

Uses problem-solving skills in diagnosing and repairing simple malfunctions in technological systems.

Uses skills of "data interpretation and display" when collecting and analyzing data related to various technologies:

- tables/charts/graphs
- measures of central tendency.

Suggested Strategies/Activities

Select activities that will enable students to investigate principles that govern the operation of a variety of familiar technologies used at home and in the workplace. Relate concepts that are learned to practical strategies for using and maintaining the technologies examined.

Initial investigations may focus upon simple devices with relatively few components. Following these activities, encourage students to trace energy flow through more complex technological "systems" that involve the application of several subsystems. Ask students to bring old or non-functional tools and appliances for analysis. Determine how these systems work, what is wrong with them, and make repairs where possible.

Model strategies and skills that are appropriate to testing and/or designing a technological device. Assist students to relate specific skills that are used to an overall framework (see Methodology, "A Framework for Conducting Investigations in Science"). Additional suggestions for technological problem solving are provided in the *Teacher Resource Manual:* Science and Technology.

Encourage students to pose/answer questions about the technologies they investigate:

e.g.,
- How does it work?
- How do I use it?
- How can I maintain/repair it?
- How can I improve it?

Students learn by reflecting on what they have done and will gain understanding by discussing and talking about their work. Provide opportunity for students to:

- work independently, as well as in small groups
- engage in group discussion where observations/procedures are shared
- summarize and explain outcomes to others.

Provide frequent opportunity for students to report, summarize and communicate the outcomes of investigation through informal writing activities. The process of writing enables students to sort/relate ideas and at the same time internalize observations and outcomes. Strategies that will support students in their use of writing skills are provided in the *Teacher Resource Manual*: Communication Skills.

LEARNING OBJECTIVES

CONCEPTS (continued):

DEMONSTRATES AN UNDERSTANDING OF BASIC SCIENTIFIC PRINCIPLES ASSOCIATED WITH THE FUNCTIONING OF SIMPLE TECHNOLOGICAL DEVICES.

- Identifies and explains relevant scientific facts, laws and theories related to two or more of the topics suggested below:
  - machines
  - electricity and/or electronics
  - heat and thermal systems
  - fluid systems.
- Applies scientific principles that are investigated in explaining the operation of familiar technological devices.

DEMONSTRATES AN UNDERSTANDING THAT MANY TECHNOLOGICAL SYSTEMS USED AT HOME AND AT WORK CONSIST OF COMBINATIONS OF SUBSYSTEMS THAT WORK TOGETHER IN ACCOMPLISHING A PARTICULAR TASK.

- Gives examples of technological systems that consist of combinations of mechanical, electrical, thermal and/or fluid subsystems.
- Identifies subsystems, component parts and energy flow within at least one technological system.

DEMONSTRATES AN UNDERSTANDING THAT SCIENCE CAN BE USED TO ADVANCE TECHNOLOGY AND TECHNOLOGY CAN BE USED TO ADVANCE SCIENCE.

- Gives examples of situations where science leads to advances in technology.
- Gives examples of situations where technology leads to advances in science.

DEMONSTRATES AN UNDERSTANDING OF NEW AND EMERGING TECHNOLOGIES AS THEY RELATE TO PRACTICAL SITUATIONS.

- Identifies a recent technology, the need it was intended to satisfy, and the process by which it was developed.
- Infers the impacts of this technology on individuals and society.

Related Life Skills

Recognizes the beneficial and harmful effects of electrical resistance. Uses this knowledge in:

- understanding the operation of electrical-thermal technologies (e.g., toaster, hair dryer)
- selecting appropriate wire size/lamp size when repairing or constructing simple devices.

Understands the household electrical system in terms of:

- energy source
- method of distribution through home circuits
- safety procedures and devices (e.g., grounding, fuses, circuit breakers).

Recognizes how basic principles related to heat contribute to the functioning of familiar thermal technologies:

- radiator caps
- special purpose thermometers
- thermostats
- frost plugs
- expansion joints
- cookware/thermos
- microwave ovens
- central heating systems.

Recognizes how basic principles related to the behaviour of fluids contribute to the functioning of familiar fluid technologies:

- hydraulic systems
- pneumatic systems
- water pumps
- home plumbing system.

Develops a strategy for improvising/creating simple devices that serve an intended purpose in practical situations:

- identifies a problem or need
- considers alternative approaches/designs
- selects a design and constructs the device
- tests and troubleshoots the device.

Related Applications Across the Curriculum

Social Studies

Recognizes ways in which developments in technology have affected:

- business and industry
- employment opportunities
- personal lifestyle
- the environment.

Identifies political and economic perspectives that may affect decisions that are made about technology.

Understands the political process and ways in which laws/regulations may be passed to control certain kinds of technological development.

Occupational Courses

Identifies potential occupational and entrepreneurial opportunities that involve operating/repairing selected technologies.

Applies knowledge of scientific principles when operating/maintaining technological devices and systems in the workplace.

Demonstrates ability to use problem-solving and decision-making skills when:

- troubleshooting and repairing simple malfunctions in tools/equipment
- providing customer repair services.

Identifies safety procedures related to the use of technological products and processes in the workplace. Interprets appropriate safety symbols and signs.

Improvises simple devices that will assist in the accomplishment of specific tasks in the workplace:

- block and tackle systems
- ramps.

Suggested Strategies/Activities

Encourage students to examine the ways in which technology responds to the wants and needs of society. Ask students to identify:

- practical problems encountered at home or at work
- recent technological products/processes that have been/could be developed in response to these problems.

Brainstorm and debate current problems/issues related to our use of technology at home, at work, in transportation and in recreation. Gather information by using learning resources that give a current perspective on problems/issues that are identified (e.g., periodicals, films, videos, guest speakers). Structure discussion by using semantic webs, idea diagrams and critical thinking strategies (see *Teacher Resource Manual*: Communication Skills).

Community Partnerships:

- Visit local business/industry and observe the use of technological products/processes (e.g., service station, restaurant, appliance repair shop, construction site).
- Invite a local mechanic, carpenter, electrician or other tradesperson to discuss basic scientific principles that govern the operation of the tools and equipment they use.
- Visit a local power generating plant and note energy transformation and applications of mechanical/electrical systems.
- Invite a representative from the local electrical company to discuss electrical distribution and technology in the home.
- Invite a doctor/nurse to discuss hazards inherent in the use of various technologies, and to identify related safety practices.
- Invite a local MLA, alderman or councillor to discuss recent laws/regulations/debate with respect to the use of certain technologies.
- Arrange visits/interviews with scientists and engineers. Distinguish between the nature of the work performed by scientists and engineers.
- Interview several senior citizens. Ask them to describe ways in which society has changed over the last 30-50 years as a result of developments in technology.

SCIENCE 16

MANAGING ENVIRONMENT AND RESOURCES

OVERVIEW:

Human populations have had considerable impact upon the environment and our natural resources. As members of society, we must ensure that science and technology are used in ways that will minimize the impact of an increasing population on our fragile biosphere. This theme will enable students to:

- identify an environmental issue that arises from the local use of natural resources
- investigate the issue by considering a variety of related factors
- suggest an action plan to deal with the environmental issue.

ATTITUDES:

Students will be encouraged to:

- display a positive attitude toward the learning of concepts and skills in science by
  - showing interest and curiosity through willingness to ask questions, share observations and ideas, and seek answers
  - performing investigations and completing assignments independently and in cooperation with others
- appreciate the fragility of the biosphere
- appreciate the interdependence of self with other living forms and with the environment
- appreciate that environmental issues involve significant relationships among science, technology and society
- realize our inability to anticipate the environmental effects of human activities
- appreciate that the collective action of individuals can have significant impact
- develop a sense of personal responsibility in relation to environmental issues.

LEARNING OBJECTIVES

SKILLS:

DEMONSTRATES ABILITY TO IDENTIFY AN ENVIRONMENTAL ISSUE RELATED TO THE LOCAL USE OF NATURAL RESOURCES, TO CONSIDER FACTORS RELATED TO THE ISSUE, AND TO APPLY RELATED INFORMATION IN DEVELOPING AN ACTION PLAN TO DEAL WITH THE ISSUE.

- Identifies an environmental issue related to the local use of natural resources.
- Gathers information related to the issue through observation, interview and/or research.
- Designs experiments, through class discussion, that illustrate how particular practices or products are related to the issue and influence environmental quality.
- Analyzes and assesses information by identifying patterns and relationships, by judging the reliability/validity of information gathered, and by considering consequences.
- Communicates the results of investigation verbally, through the use of models and diagrams, and/or through written expression.
- Takes an informed position on the issue, identifying strategies that may be used to deal with the situation.

CONCEPTS:

DEMONSTRATES AN UNDERSTANDING THAT THE BIOSPHERE IS A THIN LAYER ON THE SURFACE OF THE EARTH, ABLE TO SUPPORT LIFE.

- Identifies components of the biosphere that provide the essentials of life.
- Relates components of the biosphere to their importance in sustaining life.

DEMONSTRATES AN UNDERSTANDING THAT A CONTINUOUS SUPPLY OF SOLAR ENERGY IS ESSENTIAL TO LIFE.

- Illustrates with at least one example how living things acquire their energy either directly or indirectly from the sun.
- Explains how photosynthesis and respiration are involved in energy conversions necessary for life.
- Traces energy transfer from one feeding level to another within a food pyramid, and describes how energy is lost at each transfer.

DEMONSTRATES AN UNDERSTANDING THAT LIFE DEPENDS UPON RECYCLING PROCESSES.

- Illustrates with at least one example how biochemical cycles provide a continuous supply of materials necessary for life.
- Explains how materials are decomposed through the recycling process.
- Explains how biodegradable materials reduce the impact of man-made products on the environment.

Related Life Skills

Recognizes the vast range of waste materials produced in the local community, and how these materials may affect personal health and environmental quality.

Recognizes the value of biodegradable products in protecting the environment. Uses biodegradable products when appropriate:

- paper products rather than plastic products
- natural fibres rather than synthetic fibres
- organic cleaning agents rather than chemical cleaners
- peat moss/manure rather than chemical fertilizers.

Recognizes that there are often unforeseen consequences associated with the use of modern technologies:

- use of herbicides and pesticides
- use of fossil fuels.

Identifies local practices that have a disruptive influence on natural food chains, and predicts the long-term effects of these practices on the local environment:

- hunting/extermination programs
- pollution/waste disposal
- urban development
- use of biocides.

Recognizes global factors that threaten the health of our environment:

- acid rain
- radioactive fallout
- destruction of the ozone layer
- greenhouse effect.

Recognizes how our natural resources contribute to environmental quality. Identifies measures that can be taken to avoid waste and abuse of local natural resources:

- soil, water, atmosphere
- minerals and fossil fuels
- forests and wildlife.

Related Applications Across the Curriculum

English

Reads/interprets environmental information presented in newspapers/magazines/books.

Examines environmental issues in the theme "Beyond Now".

Uses skills of "reporting/making notes" when gathering, recording and organizing information related to environmental issues:

- selects suitable sources for gathering information
- makes lists
- outlines
- summarizes
- synthesizes notes
- reports.

Uses skills of "discussing" when evaluating and applying the findings of investigation to personal situation:

- differentiates between fact and fiction
- forms personal opinion
- permits/respects opinions of others
- recognizes that an issue can have two sides
- asserts personal opinion.

Mathematics

Uses skills of "data interpretation and display" when gathering, recording, and organizing information related to environmental issues:

- conducts a survey or poll in the local community
- determines appropriate measures of central tendency (e.g., mean, median, mode, range)
- gathers and records data using tally sheets and frequency tables
- reads and interprets information provided in list/table/chart/graph form
- organizes and displays data in table/chart/graph form.

Suggested Strategies/Activities

Develop an understanding of concepts and skills through learning activities that provide a current perspective on local ecological issues and problems. Instruction should enable students to recognize:

- their dependence on living and non-living factors in the local environment
- environmental issues that are a matter of current concern in the local community
- strategies for dealing with environmental issues and problems.

Assist students to develop the required knowledge base by providing a variety of "input" activities:

- films/videos/computer software
- field trips into the local environment
- guest speakers from local environmental agencies
- research (newspapers, magazines, booklets/pamphlets available from government and community organizations).

Illustrate to students how the framework for conducting investigations in science (see "Methodology" section) provides an overall structure that can help them to investigate environmental issues. Discuss and model skills that may be appropriately used throughout the investigative process.

e.g.,
- defining a problem or issue
- using an experimental design or research plan
- looking at both sides of an issue (i.e., economic vs environmental)
- looking for patterns and relationships
- considering consequences
- developing consensus within a group.

Additional suggestions for investigating and resolving environmental issues are provided in the *Teacher Resource Manual*: Science, Technology and Societal Issues.

Encourage students to assimilate, organize and summarize information they gather by drawing "idea diagrams" and "semantic webs" (see *Teacher Resource Manual*: Communication Skills). Prompt students to recall ideas through brainstorming activities and by asking appropriate chains of questions:

- Why did . . . happen?
- What might happen if . . .?
- How does . . . cause . . .?

LEARNING OBJECTIVES

CONCEPTS (continued):

DEMONSTRATES AN UNDERSTANDING OF HOW LIVING ORGANISMS IN THE LOCAL ENVIRONMENT INTERACT WITH EACH OTHER AND WITH THE PHYSICAL ENVIRONMENT.

- Identifies physical factors that influence local populations.
- Describes how interactions among organisms affect populations.
- Illustrates with at least one example the impact of living organisms on the local environment.

DEMONSTRATES AN UNDERSTANDING OF HOW INDIVIDUALS AND SOCIETY INFLUENCE THE QUALITY OF THE ENVIRONMENT.

- Identifies familiar technological products and processes that produce materials that are not readily decomposed.
- Gives at least one example of a local land-use practice resulting in major changes to the environment.
- Describes the relationship between densely populated areas and the production of wastes that exceed the environment's capacity to recycle.
- Gives examples of how technological developments and societal actions may improve the quality of the local environment.

DEMONSTRATES AN UNDERSTANDING THAT DEVELOPMENTS IN SCIENCE AND TECHNOLOGY MAY HAVE UNFORESEEN CONSEQUENCES ON SOCIETY AND THE ENVIRONMENT.

- Gives examples of how science and technology develop in response to societal needs.
- Explains how scientific/technological developments, while meeting human wants and needs, may create or intensify environmental problems (e.g., pollution).
- Identifies examples of the unforeseen consequences of science and technology in the local area.
- Evaluates the societal impact of at least one development in science and technology.

DEMONSTRATES AN UNDERSTANDING THAT INDIVIDUALS AND SOCIETY CAN BECOME INVOLVED IN THE RESOLUTION OF ECOLOGICAL PROBLEMS THAT ARISE.

- Identifies ways that an individual can provide a degree of direction and control over local use of environment and resources (e.g., personal habits, lobby groups).
- Identifies ways that society can influence science/technology in resolving ecological problems (e.g., voting, legislation, provision of fiscal and manpower resources).

Related Life Skills

Recognizes methods used to dispose of solid waste materials in the local community. Considers the advantages/disadvantages of methods being used.

Identifies major sources of noise pollution in the local community. Recognizes the effects of noise pollution on personal health. Identifies local noise bylaws and regulations.

Recognizes local regulations designed to control air pollution:

- smoking restrictions
- pollution standards for automobiles
- regulations on smoke stacks.

Recognizes ways in which individuals and society can become involved in resolving environmental problems:

- personal habits
- lobby groups
- voting
- provision of fiscal/manpower resources.

Follows local policies and controls designed to protect the environment. Accepts personal responsibility for protecting the quality of the environment by identifying household practices that will:

- reduce the production of waste materials
- facilitate the recycling of waste materials
- ensure the safe disposal of toxic wastes
- maintain the quality of community water, soil and air supplies.

Related Applications Across the Curriculum

Social Studies

Recognizes how our use of environment and resources may affect:

- employment opportunities
- quality of life.

Identifies agencies/practices in the local community that foster environmental awareness and conservation of resources:

- recycling programs
- hunting and fishing regulations.

Identifies environmental issues/problems of local, provincial, national and international significance. Uses decision-making skills to develop alternative strategies for dealing with these issues:

- disposing of community refuse
- decreasing levels of acid rain.

Develops an understanding of the political process and the way in which laws/regulations are legislated.

Demonstrates an awareness of legislation that has been passed to protect the quality of our environment.

Realizes that, as citizens and voters, we frequently encounter issues relating to our use of environment and resources. Accepts responsibility, as a member of democratic society, to conserve resources and protect the environment.

Occupational Courses

Appreciates the need for environmental controls in the workplace. Recognizes short-term and long-term effects of improper sanitation procedures on others and the environment.

Identifies appropriate strategies for:

- storing, disposing of and recycling waste materials used in the home, community and workplace
- minimizing the environmental impact of materials and procedures used in producing a product or providing a service.

Recognizes occupational and entrepreneurial opportunities that exist in areas of environmental concern.

Suggested Strategies/Activities

Emphasize the use of critical thinking skills. Students need to be encouraged to consider all factors and viewpoints related to a given issue, and to justify the conclusions drawn and the personal action plans adopted. A variety of strategies that will guide students through the process of analysis and critical thought have been provided in the *Teacher Resource Manual*: Communication Skills, "Using Critical Thinking Skills".

e.g.,
- PMI (Plus-Minus-Interesting)
- CAF (Consider All Factors)
- OPV (Other People's Views)
- C and S (Consequences and Sequels).

Provide frequent opportunity for students to report, summarize and communicate the outcomes of investigations and discussion through informal writing activities. The process of writing enables students to sort and relate ideas, and helps the learner to internalize observations and outcomes. Strategies that will support students in their use of writing skills are provided in the *Teacher Resource Manual*: Communication Skills, "Summarizing, Evaluating and Communicating Ideas in Science".

Community Partnerships:

Investigation and research should involve direct contact with the local community and environment. The activities suggested below provide opportunities for students to learn through observation and interview within the local community.

- Invite a wildlife officer, agriculturalist, forestry official or environmentalist to discuss concerns related to local use of the environment.
- Interview a long-time local resident who can describe ways in which the local environment has changed during the last 20-50 years.
- Observe land erosion by taking a field trip to an eroded area or an erosion prevention project.
- Interview local officials responsible for water quality/noise control/disposal of solid wastes.
- Visit local facilities used for water purification/ sewage treatment/waste disposal.
- Visit a recycling plant.
- Invite local aldermen, councillors or MLA's to discuss current policy and debate relating to pollution and environmental quality.
- Visit local companies involved in extracting, refining or using fossil fuels. Investigate the effects of these processes on the environment.

SUGGESTED OPTIONS

In situations where Science 16 is offered through more than 75 hours of instruction, teachers may wish to enrich their program through the study of optional content. While there is no requirement that optional content be included in the science program, two optional topics have been provided as a service to teachers:

- Food and Microbes
- Using Light and Sound.

The outlines that follow will assist teachers who wish to develop these topics as optional content.

FOOD AND MICROBES

OVERVIEW:

This topic is intended to develop an understanding of the role of micro-organisms in food production and in food spoilage. Activities will enable students to investigate the use of various technologies in preparing, preserving and protecting our food. Students should recognize safety standards for preparing and handling foods, and anticipate health problems that may result if safety standards are not maintained.

ATTITUDES:

- Appreciates the relationship between science and technology.
- Appreciates the contributions of science and technology in developing safe methods of preparing and preserving food products.
- Displays responsible attitudes toward the preparation and handling of food.

SKILLS:

- Uses the skills of science to investigate the effects of molds, yeasts and bacteria on foods under varying circumstances/conditions.
- Identifies common symptoms of food poisoning and appropriate recovery techniques.
- Follows appropriate procedures for preparing, preserving and handling familiar foods.

CONCEPTS:

- Describes the useful/harmful properties of bacteria, yeasts and molds.
- Demonstrates an understanding of the role of microbes in the production of various foods (e.g., bread, wine, beer, cheese, yogurt).
- Explains the role of microbes in food spoilage.
- Identifies health problems that result from improper food preparation and handling procedures.
- Demonstrates an understanding of technological processes used in preserving and protecting human food (e.g., drying foods, using additives, using acids, preserving with heat/cold).
- Describes safety standards for preparing and handling foods.

USING LIGHT AND SOUND

OVERVIEW:

Learning objectives will focus attention on basic scientific principles related to the behaviour of light and/or sound. Students will apply the scientific principles they investigate in developing explanations of natural phenomena, as well as in explaining the operation of familiar optical and/or acoustical technologies. Activities should provide opportunities for students to examine, test and construct simple devices/systems that illustrate technological applications of light and/or sound.

ATTITUDES:

- Appreciates the utility of scientific processes/skills in explaining natural phenomena.
- Develops confidence in personal ability to understand and solve practical problems through the use of science and technology.
- Appreciates the relationships among science, technology and society.

SKILLS:

- Uses the skills of science to investigate scientific facts, laws and theories related to light and/or sound.
- Analyzes, tests and troubleshoots simple optical and/or acoustical devices, identifying component parts and scientific principles that are utilized.
- Uses a problem-solving strategy to design and construct a simple technology that applies basic principles of light and/or sound.

CONCEPTS:

- Explains, by giving examples, how scientific knowledge about light and/or sound is used to solve practical problems and satisfy human needs/wants.
- Demonstrates an understanding of basic scientific principles associated with the functioning of familiar optical and/or acoustical devices.
- Gives examples of familiar technological systems consisting of combinations of different subsystems (e.g., optical, acoustical, electrical, mechanical) that work together in accomplishing a particular task.
- Demonstrates an understanding of new/emerging technologies that involve the application of knowledge about light and/or sound.

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